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Square Wave Oscillator

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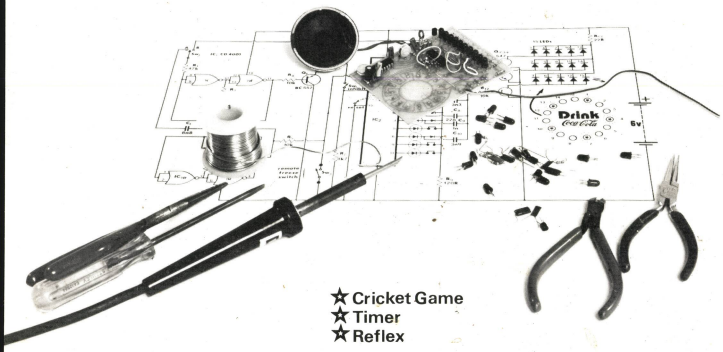

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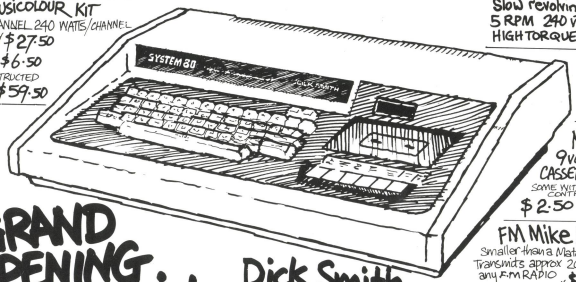

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TALKING ELECTRONICS

Editorial...

Vol.1 No.3

With this third issue we have consolidated four of our main themes. You will notice our projects extend through a number of issues, becoming progressively more involved as they run and link up with other projects to produce a complex result; more complex than you would have accepted if it were presented individually.

Our circuit descriptions are very basic and are aimed at the beginner. In our field of digitals, the circuits do not come any simpler and we can only extend upwards and outwards from this ground plane. If you feel unfamiliar with some of the terms and terminology I suggest you join an electronics club. Electronics is so fulfilling you will find yourself eating, drinking and sleeping electronics. It can become your whole life. To become a competent electronics person, this is the way it must be. We are providing the ground plan. It is up to you to apply the data. Let's see.

Colin Mitchell.

Technical
-Craig Jones

Artwork
-Steven Babidge

Enquiries
10 Minute queries will be tackled on 550-2386

Advertising
-Bill Heath 550 2386

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POWER SUPPLY

by Ashley Emery

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A fully regulated 1 Amp power supply suitable for our range of projects.....

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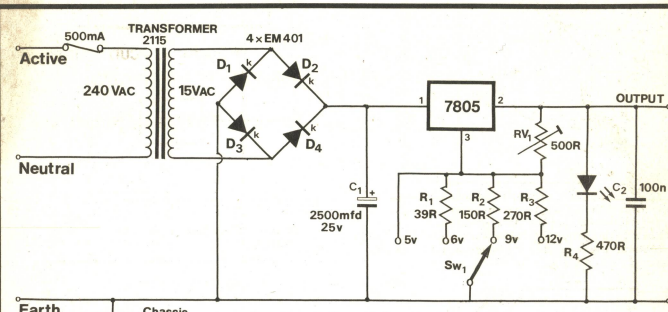


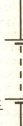
Regulated Power Supply Circuit

Our 1-amp power supply.....

If you take the Editors advice and build at least one project a month, you will soon realize how quickly you go through batteries. But don't be put off, build a fully regulated power supply.
As well as powering all the projects in this magazine, its voltages are suitable for powering items such as TV games, race car sets and calculators.
This power supply provides 4 useful fixed voltages: 5v, 6v, 9v and 12v; all at less than 100mv ripple, at full load current of 1 amp.
The 5v range is required for TTL projects and those calculators which use 3 penlite cells. It is important to keep the voltage below 6v for these circuits as the TTL IC's operate on a narrow voltage of 4.5v to 5.5v.
The maximum current capability of this power supply is 1 amp. If you happen to overload the output, don't worry,full overload protection is provided by the 7805 regulator.

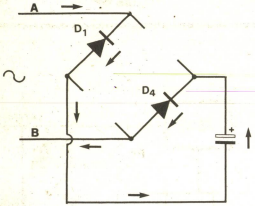
HOW IT WORKS

The operation of the circuit is very simple and can be explained with the aid of three diagrams. There are two ways of expressing the flow of electricity around a circuit. CONVENTIONAL CURRENT FLOW and ELECTRON FLOW. We will be considering the direction in which the electrons flow and it may look as if we have made a mistake according to the direction of the arrow on the diode. Unfortunately when the diode was invented, and its symbol introduced, the inventors of the day naturally thought electricity flowed out of the positive terminal of the battery and into the negative. This means that when a diode was inserted into a circuit with the anode lead towards the positive terminal of the battery, it was forward biased and the current would flow out of the cathode of the diode. Thus they drew the arrow in the direction of the supposed current flow. It was later discovered current was a flow of free electrons and the arrow became known as the direction of CONVENTIONAL CURRENT FLOW. Our description of ELECTRON FLOW will be against the arrows. The 240v AC from the mains is stepped down to 15v AC by the transformer. This voltage is then rectified by 4 diodes D_1 D_2 D_3 and D_4. They are

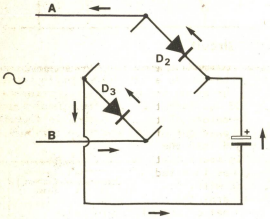


Few, if any, hobby clubs allow mains projects to be constructed as there can be a danger of faulty wiring producing a nasty shock. This project must be inspected by your teacher before turning it on.

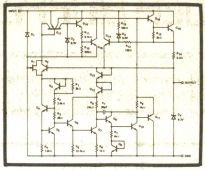
arranged as a "Bridge Rectifier". Although there are 4 diodes, only 2 are in operation at any one time. If we take the instant where the electrons are emerging from point A of the 15v winding, diodes D_1 and D_4 are the only two which allow the electrons to flow. Diodes D_2 and D_3 are reverse biased and have no effect on the circuit. The path becomes as shown in this diagram: The electrons are charging the 2500mfd electrolytic.



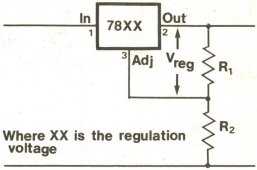
One half cycle later, the electrons are emerging from point B and diodes D_3 and D_2 are fully conducting, while D_1 and D_4 have no effect. This exchange takes place 100 times per second so that the 2500mfd electrolytic receives a small amount of energy in each ½ cycle.



For toys such as slot cars or train sets, this voltage would be sufficiently good enough. But for projects containing CMOS IC's and pulse circuits, the ripple contained within this DC voltage would cause false triggering. In addition we are designing a power supply which is variable from 5v to 12v. So to further smooth this voltage and accurately reduce it to 5v, we need a VOLTAGE REGULATOR. For this function we have chosen a 7805. It looks very much like an ordinary transistor and could very well be mistaken for one. It is a three-leaded device with pins labelled: IN, COMMON and OUT.



INTERNAL CIRCUIT (7805)



It is basically a 5v regulator but with clever circuit design, can be arranged to regulate to almost any voltage and still maintain the capacity to shut-down should the current rise to beyond about 1 amp. The two external resistors needed to provide this higher voltage can be obtained from the formula:

$R_1 = \frac{V}{.02}$ R_1 is the resistor connected between pins 2 and 3.

$= \frac{5}{.02}$ V is the normal voltage of the regulator (in our case 5v)

=250 ohms.

Use a 500 ohm trim pot which can be adjusted down to 250 ohms.

$R_2 = \frac{D}{.025}$ R_2 is the resistor connected between pin 3 and ground D is the difference between the normal output voltage of the IC and the required output voltage. In our case these are: 0v, 1v, 4v, and 7v.

The values of R_2 work out to be 0 ohms, 39 ohms, 150 ohms and 270 ohms.

QUESTION: Can you measure the output current of this regulated power supply by placing an ammeter across the output?

ANSWER: NO, definitely not! The power supply will see the ammeter as a SHORT-CIRCUIT and will shut down to give zero output. To overcome this, use a 20 ohm 10watt resistor in series with the ammeter on the 12v or 15v range and read the current flowing.

A LED (connected through a dropper resistor) is used as a POWER ON indicator and is placed at the output of the power supply to give an approximate visual indication of the voltage appearing at the terminals.
Normally this is the last place you would place a LED as the wide range in voltage would damage it. We have overcome this by providing a series resistor limiting the current to 20 ma on the 12v range. This means the LED will be just illuminated on 5v.
The 0.1mfd capacitor across the output reduces noise and spikes.

CONSTRUCTION

Assembling the power supply is relatively simple, but extra care is needed with the mains wiring and it is recommended that someone in authority check the wiring before switching on.
Begin construction by soldering the components onto the PC board. Care is needed when fitting the polarised components such as the diodes and electrolytics to avoid damage. Next wire the mains transformer and mains cord in accordance with the wiring diagram. When connecting the mains wires to the terminal block, make sure the active and neutral leads are well insulated from the case. The earth lug must be firmly attached to the case. Actually the earth lead should be the longest of the three leads and should never be stressed during assembly as it is required to be the last wire to break when the power lead is tugged.
Connect 11 short lengths of hook-up flex to the PC board and follow the diagram for their terminations. For example: "A" on the PC board goes to "A" on the transformer. Use 9mm spacers to stand the board off the bottom of the case.

This project does not lend itself to being fitted into a plastic box as most commercially available boxes are not big enough to provide adequate ventelation. Providing a sufficiently large enough heatsink in a plastic box is also difficult. However a special ventelated box is available from A&R Soanar and has internal slots to take the heatsink.

HEATSINKING

If you intend to use this power supply to replace a small 9v battery in any of our projects, you will not need to heatsink the regulator IC. It's only when the power requirements near 200 - 300 ma on the 5v or 6v range that the IC will need to be kept cool.
A suitable heatsink is available from Dick Smith (Cat No H-3401 or H-3422). The IC is firmly bolted to it through a hole in the back of the case. If you are using a plastic case, the heatsink will be positioned inside the case. Make sure the leads of the IC do not touch the heatsink.

TESTING

Once construction is complete it is very wise to have the whole unit checked over and tested by a qualified person. The 500 ohm pre-set must be adjusted to 250 ohms. This can be done by simply setting the wiper to the mid position. Switch the unit on and test the output voltage with a voltmeter. Place a 22 ohm 5watt resistor across the output terminals and set the rotary switch to each of the four voltages. You will find the voltage will be within 0.5v of that specified.

PARTS LIST

1 - 39R ½watt 5%
1 - 150R " "
1 - 270R " "
1 - 470R " "
1 - 500R large vert. mount preset

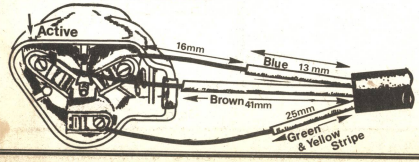
Capacitors:
1 - 0.1mfd greencap
1 - 2500mfd electro PC mounting

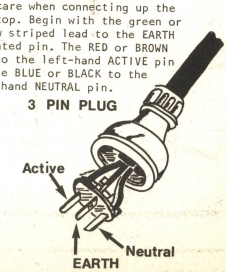
Semiconductors:
4 - EM401 1-amp silicon diodes
1 - 7805 5v regulator
1 - large RED LED.

Miscellaneous:
1 - 2155 15v @ 1amp transformer
1 - fuseholder with 0.5amp fuse
1 - 3-way terminal block
1 - power cord with plug ← From: D.Smith
1 - 150mm x 76 x 134 metal case
1 - 75mm heatsink
1 - 240v SPST switch
1 - 3-pole 4-way rotary switch
1 - "Power supply" PC board
2 - banana plugs and sockets (one red, one black)
cable clamp, nuts and bolts, spacers, PC pins, solder lugs, grommet.

WIRING A PLUG-TOP

Take care when connecting up the plug-top. Begin with the green or yellow striped lead to the EARTH or plated pin. The RED or BROWN goes to the left-hand ACTIVE pin and the BLUE or BLACK to the right-hand NEUTRAL pin.

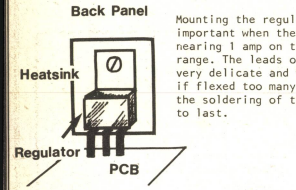




If you would like a continuously variable supply you can replace the rotary switch with a 500 ohm potentiometer and solder the middle tag to "J" on the board and the left-hand tag to "K". ("G", "H" and "I" can be omitted). This will give an output of 5 - 17v and it is recommended that a scale be fitted around the pot or connect a 20v panel meter across the output to give a visual indication of the voltage.

Use these layout diagrams to help you with assembling the power supply. Your own particular layout will depend on many factors such as the type of transformer, size of box and the shape of the fuse holder and switch.

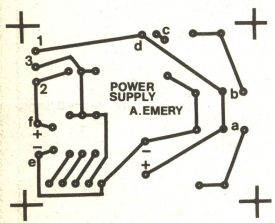
Do not use a double pole switch as you may wire it incorrectly and produce a short-circuit across the mains! Use a single pole switch in the active line so that you cannot make this mistake.

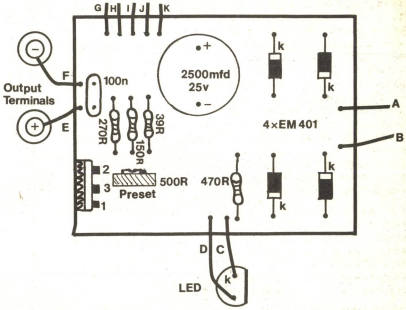


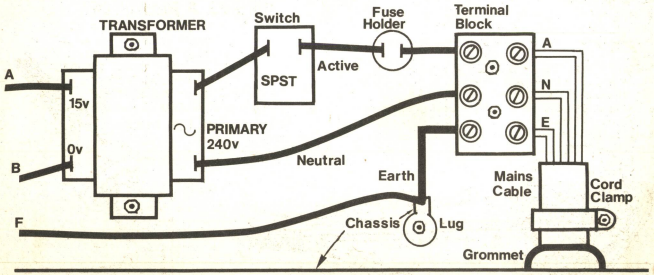
Mounting the regulator IC is only important when the demand is nearing 1 amp on the low voltage range. The leads of the 7805 are very delicate and will break off if flexed too many times. Leave the soldering of the regulator to last.

LAYOUT DIAGRAMS

ROTARY SWITCH
(3 Pole, 4 Position)







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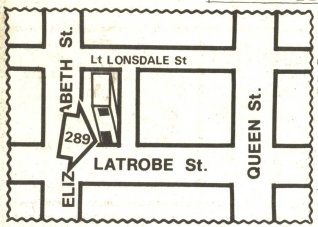

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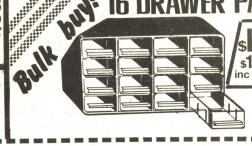

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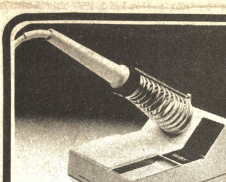

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Prices plus 15 percent sales tax.

TOP QUALITY LOW COST TRANSFORMERS

R-2150-2851
Primary: 240V AC.
Secondary Voltage: 12.6 volts CT.
Secondary Current: 150mA.
Termination: Flying leads.

$2.50
10 up $2.10

R-2155
Primary: 240V AC.
Tapped Secondary Voltages: 6.3, 7.5, 8.5, 9.5, 12.6, 15.
Secondary Current: 1 amp.
Termination: Solder lugs on transformer.

$3.90
10 up $3.51

R-6672
Primary: 240V AC.
Tapped Secondary Voltages: 15, 17.5, 20, 24, 27.5, 30.
Secondary Current: 1 amp.
Termination: Solder lugs.

$6.19
10 up $4.95

$2000 8" (200mm) wide range general purpose. Includes transformer, mounting holes for P.A. and background use. Very smooth over-all response 45 Hz-12 KHz. Fitted to a 1.9 cubic ft vented enclosure they sound unbelievable.
8 Ohm 8 Watt RMS 5.6 oz magnet.
$6.00 TRADE, $6.95 Inc. tax

TEXAS INSTRUMENTS CALCULATORS

Ti 25	$19.04
Ti 30 SP	$22.85
Ti 50	$38.09
Ti 55	$54.09
Ti 58C	$141.50
Ti 59	$295.00
PC-100C	$240.00

(Printer/Plotter for Ti 58C and Ti 59)

Speak and Spell	$77.78
Dataman	$24.26
Little Professor	$17.62
AC9131 AC Adaptor/Charger for Ti 58C/59	$7.06

Calculators plus 15 percent sales tax if applicable. Full range of calculators and accessories in stock.

DIRECT IMPORT PANEL METERS AT LOW, LOW PRICES

MU-65 1MA — 120 ohms
100uA — 1400 ohms
Dimensions: Overall — 100mm(W) x 82mm(H)
Scale — 100mm(W) x 50mm(H)
Mounting: Hole required — 63mm
Bolt centres — 80mm(W) x 64mm(H)
Nuts and washers provided

$10.18 ea. plus $1.52 tax

MU-45
O-1MA-120 ohms
O-50UA-1400 ohms
O-5ADC-3 Shunt
0-30VDC-100 ohms

$6.45 ea.
plus 97c tax

MU-45 VU METER
VU (OdB equals 1mW into 600ohms)
—1,000ohm

$7.35 ea.
plus $1.11 tax

MU-45 DIMENSIONS
Overall — 58mm(W) x 52mm(H)
Scale — 58mm(W) x 31mm(H)
Hole required — 44mm
Bolt centres — 38mm(W) x 38mm(H)
Nuts and washers provided
10 or more less 10 percent

EXTRA SPECIAL

2N 3055 TRANSISTORS
FULL SPEC. MOTOROLA
55c ea. plus 15c tax
MJ 2955 TRANSISTORS
65c ea. plus 18c tax

OSCILLOSCOPES

Hitachi Oscilloscope V-152 DC-15MHz
Dual Trace ..... $560.00 Ex/Tax $644.00 Inc/Tax
V-302 DC-30MHz
Dual Trace ..... $955.00 Ex/Tax $1062.43 Inc/Tax
V-550 DC-50MHz
Dual Trace ..... $1795.00 Ex/Tax $1996.93 Inc/Tax

Two types of probes extra
AT10AB 1.5:10 to 1 ..... $20.00
Ex/Tax $22.25 ea Inc/Tax
AT10AC 1.5:10 to 1 and 1 to 1 switch $40.00
Ex/Tax $44.50 ea Inc/Tax

SPECIAL OFFER!

Trio Oscilloscope CS-1560A-11. 130mm CR Tube, DC to 15Mhz Dual trace.

ONLY $499.00 EX/TAX

$573.85 INC/TAX

XENON FLASH TUBE

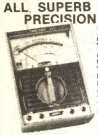
$1.83 ex
$2.10 inc Tax

Trigger Transformer To Suit 60¢

DUAL LIGHT DEPENDENT RESISTORS

60¢ EXEMPT 69¢ INC TAX

ALL SUPERB QUALITY PRECISION MADE NEW LAB SERIES



Are You Colour Conscious? You SHOULD BE! Especially when it makes work so easy... "UNISOUND" The Colour Coded multimeters. All Models have battery test too!

DT 1313 20K/Vdc 19 ranges
DT 1314 50K/Vdc 38 ranges
DT 1316 50K/Vdc 36 ranges
& AC AMPS

DT1313 $27.13
$31.19 inc tax

DT1314 $34.54
$39.72 inc tax

DT1316 $35.88
$41.26 inc tax

ELLISTRONICS

289 LATROBE ST MELBOURNE 3000
602-3282 602-3836

We stock all parts & PC's for

TALKING ELECTRONICS

REED SWITCH AND COIL.
NOW THRASHED TO RIBBONS
SWITCH 34¢ + 5¢ Tax
COIL 65¢ + 10¢ Tax

TUNING GANGS *Ideal MW & SW receivers* 85¢ ea WHILE STOCKS LAST!

VERO TYPE BOARD

	Ex Tax	Inc Tax
H5614 90x80mm	$1.10	$1.25
H5602 150x90mm	$2.20	$2.50
H5116 310x100mm	$3.44	$3.90

Plated Strips-Alpha Numeric Grid, the most versatile board of the lot. Etched copper strips are pre-drilled and plated for soldering ease. These boards have an Alpha Numeric Grid to facilitate positive Pin identification.

PRO-QUALITY 13/.12 TINNED HOOK UP WIRE
8 COLOURS in 100M rolls

BLACK BROWN RED ORANGE YELLOW GREEN BLUE WHITE

Introductory Price
$3.75 ex
Or 8 Rolls for $26.00 EX TAX
29.90 INC TAX

NEW!

POLY PACK SPECIALS

PP.1 100 Mixed Disc Ceramic capacitors $1.50

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PP.3 50 Mixed Electrolytic capacitors. RB. and RT. from 1uf to 4700uf. $2.50

PP.4 25 Assorted Potentiometers Includes slide and rotary types. $2.50

PP.5 20 Assorted Switches Includes Toggle, Rocker and Slide types $2.00

60¢ post and pack. per item

RUSH THESE!!

DIL PCB SWITCHES

	EXEMPT	INC TAX
4 Pole	$1.00	$1.15
6 Pole	$1.39	$1.60
8 Pole	$1.65	$1.90
10 Pole	$2.86	$3.29

SOLID STATE REFRIGERATION

601-4000

Low cost experimental service
Minimum ΔT = 30°C
I = 7-8 Amps
V = 3-5 VDE
Hot side Temperature = 50°C
$16.00 plus 15% Sales Tax.

801-2003

New low cost general purpose ceramic temperature control.
Maximum ΔT = 60°C or greater
Maximum current 5·5 Amps
Nominal voltage 8 V dc
Hot side temperature 50°C
$32.00 plus 15% Sales Tax.

IC SOCKETS

LOW PROFILE.

	TRADE	INC TAX
8 Pin	15¢	18¢
14 Pin	21¢	25¢
16 Pin	24¢	28¢
18 Pin	25¢	29¢
20 Pin	26¢	30¢
22 Pin	28¢	33¢
24 Pin	30¢	35¢
28 Pin	34¢	40¢
40 Pin	52¢	60¢
64 Pin	$1.10	1.27

WIRE WRAP
GOLD PLATED 3 LEVEL WRAP

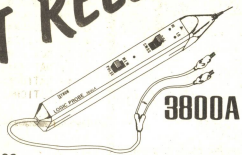
	TRADE	INC TAX
8 Pin	65¢	75¢
14 Pin	89¢	1.02
16 Pin	99¢	1.14
18 Pin	1.02	1.18
20 Pin	1.05	1.21
24 Pin	1.54	1.77
28 Pin	1.65	1.91
40 Pin	1.85	2.13

Save 25% JUST RELEASED!

ELLISTRONICS

289 LATROBE ST., MELBOURNE 3000
(03) 602-3282, 602-3836 Telex AA37758 LSTRON

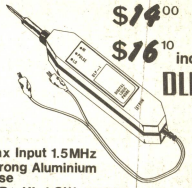
2 NEW PROBES



3800A

$22.00
$25.30 inc tax

Max Input 10MHz
Memory/Pulse Sw.
TTL/CMOS Sw.
Input Impedance 300k
Smart black plastic case
53cm leads



DLP-1

$14.00
$16.10 inc tax

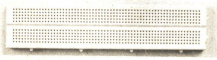
Max Input 1.5MHz
Strong Aluminium case
LEDs: HI - LOW - PULSE
80cm leads
KEY to LEDs on back of probe
Input Impedance 300k

NEW! BREAD BOARDS

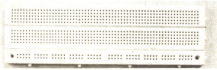
Now DIRECTLY imported at ½ cost of other breadboards!

"Cut-away" view

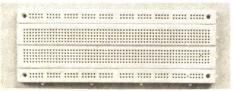
WB-DN 100 Holes
$1.98 $2.28 INC



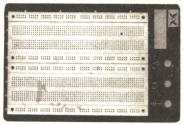
WB-TN 640 Holes
$7.57 $8.70 INC



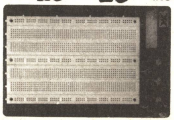
WB-2N-1 100 + 640 Holes
$9.65 $11.10 INC



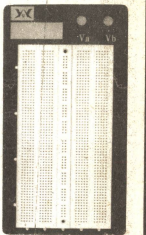
WB-2N 200 + 640 Holes
$11.21 $12.90 INC



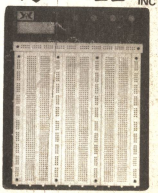
WB-4N 400 + 1280 Holes
$25.03 $28.78 INC



WB-4N-1 300 + 1280 Holes
$23.50 $27.03 INC



WB-4N-3 100 + 1280 Holes
$19.59 $22.53 INC



WB-6N 500 + 1920 Holes
$35.58 $40.92 INC

C.I.

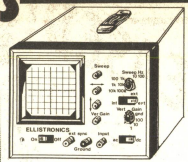
ELLISTRONICS

289 LATROBE ST. MELBOURNE. 3000

HOBBY CRO!

SPECIFICATIONS-

Weight:About 3.8kg
Size:202mm(w)x 160mm(h) x 306mm(d)
Usable Bandwidth: D.C. to 6.5 MHz plus.
Vertical deflection sensitivity: 10mV per division.
Horizontal deflection sensitivity:500mV per division.
Time base sweep frequency:10Hz to 100kHz in 4 ranges.
Synchronisation: internal and external.



$170.00 EXEMPT
+$25.50 TAX $6.00 freight

Special

HINTS FOR LOOKING UP THE SEMICONDUCTOR PRICE LIST:

CD is CMOS DEVICE
HEF is PHILIPS
MC 1 is NATIONAL
NE see LM, uA, SE, or RC.
LM340xx see also 78xx
LM350xx see also 79xx
uA is FAIRCHILD LINEAR
LM is NATIONAL LINEAR
NE is PHILIPS LINEAR
RC is RCA LINEAR
LF is NATIONAL LINEAR
LH is NATIONAL LINEAR
MM is NATIONAL MOS-LSI

SEMICONDUCTOR PRICE LIST

Sales tax code:
A: 27½%
B: 15%

7400	.25 B	7410	.21 B	7486	.35 B	74713	1.32 B	4490FP	3.38 B	4559	3.09 B	74C20	.26 B
7401	.28 B	7411	.28 B	7489	1.74 B	74174	1.05 B	4490VP	2.59 B	4560	3.00 B	74C30	.26 B
7402	.28 B	7412	.28 B	7490	.53 B	74175	.83 B	4495	1.60 B	4561	1.50 B	74C32	.33 B
7403	.28 B	7413	.40 B	7491	.67 B	74176	.86 B	4500	2.39 B	4562	4.70 B	74C42	.96 B
7404	.31 B	7414	.84 B	7492	.49 B	74177	.98 B	4501	.20 B	4566	2.25 B	74C48	1.70 B
7405	.29 B	7416	.35 B	7493	.49 B	74180	.87 B	4502	1.46 B	4568	4.10 B	74C73	.62 B
7406	.33 B	7417	.33 B	7494	1.02 B	74181	1.97 B	4503	.72 B	4569	2.40 B	74C74	.70 B
7407	.34 B	7420	.28 B	7495	.60 B	74182	.98 B	4504	.90 B	4572	.75 B	74C76	.66 B
7408	.31 B	7421	.28 B	7496	.80 B	74184	2.78 B	4506	.55 B	4580	5.40 B	74C83	1.29 B
7409	.31 B	7423	.34 B	7497	3.08 B	74185	2.25 B	4507	.44 B	4581	2.63 B	74C85	1.32 B
		7425	.32 B			74189	1.57 B	4508	3.59 B	4582	.90 B	74C86	.30 B
		7426	.30 B	74107	.36 B	74190	.97 B	4510	1.20 B	4583	.80 B	74C89	6.30 B
		7427	.30 B	74109	.41 B	74191	.97 B	4511	1.20 B	4584	.68 B	74C90	1.08 B
		7430	.28 B	74116	2.31 B	74192	.97 B	4512	1.13 B	4585	.90 B	74C93	1.07 B
		7432	.31 B	74121	.40 B	74193	.97 B	4513	1.02 B	4599	3.60 B	74C95	1.25 B
		7437	.32 B	74122	.52 B	74194	.97 B	4514	2.35 B	4723	1.30 B	74C107	2.18 B
		7438	.32 B	74123	.53 B	74195	.76 B	5415	2.35 B	4724	1.05 B	74C150	2.65 B
		7440	.27 B	74125	.48 B	74196	.85 B	4516	.95 B	40097	.80 B	74C151	2.20 B
		7441	1.03 B	74126	.48 B	74197	1.32 B	4517	3.20 B	40098	.80 B	74C154	2.18 B
		7442	.59 B	74132	.76 B	74199	1.30 B	4518	.85 B	40106	.68 B	74C157	2.03 B
		7443	2.10 B	74141	1.05 B	74221	1.43 B	4519	.54 B	40160	1.08 B	74C160	1.08 B
		7444	1.60 B	74145	.92 B	74251	.76 B	4520	1.05 B	40161	1.25 B	74C161	1.25 B
		7445	.97 B	74147	1.43 B	74279	.63 B	4521	1.50 B	40162	1.25 B	74C162	1.25 B
		7446	.98 B	74148	1.32 B	74283	1.15 B	4522	1.40 B	40163	1.30 B	74C163	1.30 B
		7447	.98 B	74150	.78 B	74284	2.89 B	4526	1.56 B	40174	1.08 B	74C164	1.27 B
		7448	.86 B	74151	.78 B	74285	3.71 B	4527	1.15 B	40175	1.04 B	74C165	1.55 B
		7450	.27 B	74152	4.76 B	74290	.87 B	4528	1.26 B	40192	1.37 B	74C173	1.29 B
		7451	.29 B	74153	.75 B	74293	.87 B	4529	1.40 B	40193	1.64 B	74C174	1.08 B
		7453	.28 B	74154	1.18 B	74365	.63 B	4530	.53 B	40195	1.22 B	74C175	1.03 B
		7454	.28 B	74155	.79 B	74366	.63 B	4531	.90 B	45104	3.15 B	74C192	1.37 B
		7460	.28 B	74156	.79 B	74367	.57 B	4532	.95 B	45106	4.05 B	74C193	1.64 B
		7470	.36 B	74157	.79 B	74368	.57 B	4534	8.36 B	45107	3.15 B	74C195	1.22 B
		7472	.36 B	74160	.91 B			4536	4.30 B	45109	3.15 B	74C221	2.05 B
		7473	.36 B	74161	.91 B			4538	1.52 B			74C373	2.31 B
		7474	.36 B	74162	.86 B			4539	1.12 B			74C374	2.43 B
		7475	.48 B	74163	.94 B	8T20	4.62 B	4541	1.35 B	74C00	.27 B	74C901	.68 B
		7476	.38 B	74164	.90 B	8T26	1.89 B	4543	1.38 B	74C02	.25 B	74C902	.68 B
		7480	1.00 B	74165	1.02 B	8T28	2.10 B	4553	3.68 B	74C04	.27 B	74C903	.74 B
		7482	1.01 B	74166	1.47 B	8T80	1.75 B	4555	1.05 B	74C08	.32 B	74C904	.78 B
		7483	.79 B	74167	2.73 B	8T96	1.65 B	4556	1.05 B	74C10	.28 B	74C905	8.38 B
		7485	1.07 B	74170	1.82 B	8T97	1.92 B	4557	2.24 B	74C14	.68 B	74C906	.64 B
								4558	1.29 B				

74C907	.64 B
74C908	1.49 B
74C909	2.52 B
74C910	9.70 B
74C911	8.67 B
74C912	8.70 B
74C914	2.05 B
74C915	1.42 B
74C917	11.05 B
74C918	1.64 B
74C920	9.69 B
74C921	7.34 B
74C922	4.65 B
74C923	4.95 B
74C925	5.85 B
74C926	5.65 B
74C927	5.85 B
74C928	7.46 B
74C929J	8.13 B
74C930J	8.13 B
74C932	1.33 B
74C936	13.35 B
74C937	11.85 B
74C938	11.35 B
74C941	2.28 B
74C948N	18.75 B
74C949	15.65 B
74C949N1	5.37 B
74C989N	7.80 B
80C95	.74 B
80C96	.84 B
80C97	.84 B
80C98	.84 B
9300	.67 B
9302	1.40 B
9307	1.82 B
9308	1.12 B
9310	.59 B
9311	.88 B
9312	1.12 B
9313	1.12 B
9314	1.20 B
9368	2.27 B
9370	1.80 B
96L02	1.16 B
74LS00	.28 B
74LS01	.24 B
74LS02	.20 B
74LS03	.30 B
74LS04	.27 B
74LS05	.30 B
74LS08	.32 B
74LS10	.20 B
74LS11	.25 B
74LS12	.30 B
74LS13	.48 B
74LS14	.66 B
74LS15	.29 B
74LS20	.30 B
74LS21	.30 B
74LS22	.30 B
74LS26	.32 B
74LS27	.32 B
74LS28	.40 B
74LS30	.24 B
74LS32	.43 B
74LS33	.43 B
74LS37	.32 B
74LS38	.32 B
74LS40	.27 B
74LS42	.77 B
74LS47	1.12 B
74LS48	1.14 B
74LS49	1.24 B
74LS51	.29 B
74LS54	.29 B
74LS55	.29 B
74LS73	.47 B
74LS74	.31 B
74LS75	.48 B
74LS76	.37 B
74LS78	.39 B
74LS83	.95 B
74LS85	1.12 B
74LS86	.43 B
74LS90	.60 B
74LS92	.93 B
74LS93	.70 B
74LS95	.83 B
74LS96	.98 B
74LS107	.48 B
74LS109	.46 B
74LS112	.48 B
74LS113	.46 B
74LS114	.46 B
74LS122	.43 B
74LS123	.82 B
74LS125	.58 B
74LS126	.58 B
74LS132	.92 B
74LS133	.30 B
74LS136	.45 B
74LS138	.74 B
74LS149	.82 B
74LS151	.60 B
74LS152	2.70 B
74LS153	.70 B
74LS154	1.40 B
74LS155	.98 B
74LS156	.98 B
74LS157	.69 B
74LS158	.67 B
74LS160	.89 B
74LD161	.95 B
74LS162	.86 B
74LS163	.86 B
74LS164	1.15 B
74LS165	.70 B
74LD168	1.32 B
74LS169	1.32 B
74LS170	2.50 B
74LS173	1.18 B
74LS174	.72 B
74LS175	.54 B
74LS181	2.50 B
74LS189	3.59 B
74LS190	1.17 B
74LS191	.98 B
74LS192	.93 B
74LS193	.99 B
74LS194	.63 B
74LS195	.99 B
74LS196	1.18 B
74LS197	1.29 B
74LS221	1.09 B
74LS240	1.64 B
74LS241	1.29 B
74LS242	1.50 B
74LS243	1.50 B
74LS244	1.55 B
74LS245	2.45 B
74LS247	1.23 B
74LS248	1.23 B
74LS249	1.23 B
74LS251	.78 B
74LS253	1.00 B
74LS257	.64 B
74LS258	1.05 B
74LS259	1.86 B
74LS260	.35 B
74LS266	.44 B
74LS273	1.90 B
74LS279	.52 B
74LS283	.95 B
74LS289	3.59 B
74LS290	.98 B
74LS293	.98 B
74LS295	1.50 B
74LS298	.93 B
74LS347	1.57 B
74LS352	1.23 B
74LS353	1.33 B
74LS365	.60 B
74LS366	.60 B
74LS367	.72 B
74LS368	.60 B
74LS373	1.64 B
74LS374	1.64 B
74LS375	1.64 B
74LS377	1.96 B
74LS386	.48 B
74LS390	1.41 B
74LS393	.99 B
74LS640	2.85 B
74LS670	2.25 B
81LS95	1.54 B
81LS96	1.54 B
81LS97	1.65 B
81LS98	1.65 B
95H90	7.90 B
11C90	15.75 B
MC4024	3.83 B
MC4044	3.83 B
74F02	.77 B
74F32	1.21 B
74S00	.70 B
74S02	.70 B
74S04	.70 B
74S05	.70 B
74S14	.70 B
74S20	.70 B
74S30	.70 B
74S32	.70 B
74S51	.70 B
74S74	1.13 B
74S86	1.20 B
74S112	1.13 B
74S135	1.56 B
74S138	3.67 B
74S151	1.22 B
74S157	2.61 B
74S158	2.61 B
74S182	2.87 B
74S289	2.60 B
TIL111	1.10 B
TIL113	1.10 B
TIL115	1.08 B
TIL116	1.10 B
MCT2	.85 B
MCT2E	1.00 B
MCT6	2.65 B
MCT275	1.54 B
4N25	.66 B
4N26	.60 B
4N28	.75 B
4N31	1.10 B
4N33	1.33 B
4N35	1.26 B
MCC671	3.35 B
FCD825	1.00 B
MOC1005	1.88 B
MCS2400	2.18 B

C-MOS

4000	.19 B
4001	.19 B
4001B	.19 B
4002	.19 B
4006	.82 B
4007	.19 B
4008	.82 B
4009	.41 B
4010	.45 B
4011	.19 B
4012	.19 B
4013	.36 B
4014	.82 B
4015	.82 B
4016	.42 B
4017	.75 B
4018	.75 B
4019	.58 B
4020	.85 B
4021	.85 B
4022	.85 B
4023	.19 B
4024	.56 B
4025	.19 B
4026	1.32 B
4027	.44 B
4028	.75 B
4029	.75 B
4030	.43 B
4031	2.35 B
4032	1.28 B
4033B	1.30 B
4034	2.62 B
4035	1.10 B
4039	.78 B
4040	.81 B
4041	.78 B
4042	.68 B
4043	.68 B
4044	.68 B
4046	.95 B
4047	.75 B
4048	.60 B
4049	.46 B
4050	.37 B
4051	.71 B
4052	.89 B
4053	.89 B
4055	.89 B
4060	.89 B
4063	1.45 B
4066	.45 B
4068	.19 B
4069	.19 B
4070	.19 B
4071	.19 B
4072	.19 B
4073	.19 B
4075	.19 B
4076	.80 B
4077	.19 B
4078	.19 B
4081	.19 B
4082	.19 B
4085	.74 B
4086	.74 B
4089	1.05 B
4093	.52 B
4094	1.25 B
4099	1.54 B
4160	.82 B
4161	.82 B
4162	.82 B
4163	.82 B
4174	.82 B
4175	.82 B
4194	.90 B
4404	.86 B
4408	11.86 B
4409	9/50 B
4410	13.38 B
4411	10.40 B
4412FP	12.45 B
4412VP	9.38 B
4415FP	6.68 B
4415VP	5.00 B
4416	.82 B
4419	4.48 B
4422	7.50 B
4426	1.50 B
4428	.86 B
4435FP	6.96 B
4435VP	5.22 B
4441	.96 B
4445	1.17 B
4446	1.20 B
4447	4.10 B
4449	.57 B
4457	3.99 B
4458	8.28 B
4460	10.34 B
4469	2.13 B

LINEAR & MICRO

REF 02CJ	6.60 A
LH0022CH	12.15 B
LH0022CN	6.85 B
LH0022CD	12.45 A
LH10CLH	4.40 A
LH0042CH	5.95 B
LH0044CH	13.85 B
TL061	.97 B
LH00701H	11.69 A
LH00702H	15.00 A
LH00711H	11.69 A
TL071	.69 B
TL072	1.05 B
TL074	1.69 B
TL075	1.76 B
Z80CPU	8.06 B
Z80ACPU	10.81 B
Z80CTC	6.95 B
Z80ACTC	8.48 B

LINEAR & MICRO (CONT)

Z80P10	6.95 B
Z80AP10	9.18 B
Z80S10/0	20.43 B
Z80A S10/0	41.43 B
Z80S10/1	41.43 B
Z80AS10/1	41.43 B
Z80S10/2	41.43 B
Z80s10/9	41.43 B
Z80AS10/9	53.46 B
TL082	.97 A
TL084	2.10 B
LH0091CD	20.75 A
AF100ICJ	8.47 B
SAK140	1.76 B
UAA170	2.78 B
UAA180	2.78 B
TCA220	1.80 A
LM301	.39 B
LM301H	.99 B
LM304H	1.89 B
LM305H	.64 B
LM307CN	.65 B
LM307N	1.40 B
LM308	.71 B
LM308H	1.10 B
LM309H	2.30 B
LM310N	1.47 A
LM310H	1.79 A
LM311-8	.75 B
LM311-14	1.50 A
LM311H	1.00 A
LM318	2.58 B
LM319N	2.34 B
OM321	9.60 A
LM322	2.95 A
LM324	.65 A
LM325	2.74 A
LM329DZ	1.14 B
LM334Z	1.21 B
LM335Z	1.34 B
OM335	11.72 A
LM336Z	2.54 B
LM339N	.67 B
LM339AN	1.90 B
LF347	2.57 B
LM348	1.25 A
LM349	1.75 A
OM350	6.30 A
LF351N	.76 B
LF353	.91 A
LF356BN	1.02 B
LF356H	1.47 B
LF357	.85 B
LM358N	.56 B
LM358H	.98 B
LM370N	1.18 B
LM373	4.00 A
LM374	4.25 A
LM376	.56 B
LM377	2.30 A
LM378	2.51 A
LM379-5	5.09 A
LM380-8	1.18 A
LM380-14	1.18 A
LM381N	1.74 A
LM381A-N	2.98 A
LM382N	1.49 A
LM383	2.18 A
LM384	1.56 A
LM386N1	.80 A
LM386N3	1.22 A
LM387	1.23 A
LM389	1.01 A
LM391N-80	1.45 A
LM391N-60	1.37 A
LM393	.70 A
TBA540	3.15 A
NE543	4.50 A
LM555	.28 B
LM556	.74 B
NE558	1.47 A
LM565n	1.16 A
LM565CH	1.75 A
NE556	1.95 B
LM567CN	1.16 B
NE571	2.95 A
SAB0600	6.48 B
TBA641B11	2.35 A
UA703H	1.20 A
LM709-14	.54 A
UA710CA	.46 A
UA710CH	.66 A
LM711CN	.74 A
UA711H	.74 A
UA716HC	.80 A
LM723n	.60 B
LM723H	.70 B
LM725	2.98 A
LM733	.92 A
UA739	1.46 A
LM741	.26 B
LM741HC	1.19 B
UA747	.84 A
UA747HC	.92 A
UA748	.42 A
UA748HC	1.02 A
UA753	1.45 A
UA760HC	4.60 A
UA777	1.40 A
UA777HC	3.55 A
UA796HC	1.75 A
ADC0800PCD	13.20 B
DAC0800LCN	2.48 B
OM802	.74 B
ADC0808ccn	14.50 B
DAC0808LCN	2.23 B
TBA920	2.15 A
SAB1048	4.58 A
ADC1210HCD	44.80 B
DAC1220LCN	14.60 B
LM1303N	1.52 A
LM1310N	1.90 A
MC1406	4.72 A
MC1445	2.37 A
MC1456	1.29 A
LM1458N	.62 B
LM1488	.75 B
LM1489	.95 B
MC1494	6.93 B
MC1495	5.75 B
MC1496	1.06 A
FR1502-Fo2	15.86 B
LM1558H	1.23 A
LM1596	1.35 A
TR1602	6.00 B
MC1709	.74 A
FD1771B01	21.66 B
FD1791-B02	65.00 B
FD1793B-OR	65.00 B
LM1830	2.50 A
TR1963	8.00 B
LM1886	6.77 A
BR1941	12.60 B
TR1983	8.00 B
ULN2003N	1.50 B
2102-600nS	.95 B
2102-400nS	1.10 B
2102-250nS	1.60 B
2107	4.80 B
2112	3.20 B
2114-300nS	2.20 B
XR2206	4.50 B
2650	23.84 B
2708-450nS	6.95 B
2708CHIPOS	13.28 B
2716-450 5v	6.40 B
2809	2.50 B
LM290Z	1.40 A
LM2917-8	2.24 B
LM2917-14	2.24 B
MM3001	12.16 B
CA3028	1.23 B
CA3036	1.40 B
LM3039	.91 B
CA3046	1.36 A
LM3065	.40 A
LM3080	.87 A
UA3086	1.36 A
LM3089	3.13 A
CA3130E	1.00 A
CA3130T	1.00 A
CA3140E	.76 A
CA3140T	.99 A
LM3401	.67 A
ADD3501	9.98 B
LM3524	4.46 B
LM3661	.92 A
ADC3711	13.35 B
LM3900	.68 A
LM3905	1.04 B
LM3909	.85 B
LM3911	1.28 B
LM3914	3.16 B
LM3915	3.30 B
LM3916	3.13 B
4116-150nS	7.95 B
4116-200 LP	1.95 B
4136	1.46 A
4156	1.72 A
LM4250	1.45 A
UA4558TC	1.08 A
55101-800nS	4.50 B
5101-600nS	7.50 B
MM5203Q	14.60 B
MM5220	5.50 B
MM5303	4.46 B
MM5307AAN	15.80 B
MM5309	6.75 B
MM5312	8.00 B
MM5314	5.98 B
MM5315	6.75 B
MM5369	2.16 B
MM5387	7.50 B
MM5395n	5.52 B
NE5534	2.40 B
MM5740AAE	10.10 B
MM5387	1.18 B
M64021PL	7.47 B
6502A	12.91 B
6502	9.10 B
6505	11.34 B
6508	4.75 B
65X08	9.10 B
6520	4.78 B
6522	10.60 B
6522A	13.86 B
6532	14.70 B
6551	16.17 B
6561	4.22 B
6574	10.91 B
6674	10.60 B
6800P	9.10 B
68B00	14.70 B
6802	12.00 B
6808	10.50 B
6809	38.25 B
6810A	4.20 B
6820	5.50 B
6821	4.95 B
6840	7.84 B
6845	29.24 B
6847	13.50 B
68047	9.90 B
6850	4.40 B
68B50	15.53 B
6852	5.50 B
S6854	15.78 B
6875	6.65 B

LINEAR

ICL7106	10.50 B
ICL7107	16.62 B
TA7205	3.42 B
ICM7217A	13.80 B
ICM7218BI	16.60 B
LS7220	7.65 B
ICM7226B	30.13 B
DS7528	1.25 B
LM7555	1.48 B
ICM7556	2.84 B
ICL7632	4.84 B
ICL7660	2.87 B
Z8001	250.00 B
Z8002	195.00 B
8035	8.37 B
ICL8038CCPD	5.97 B
INS8060D	12.91 B
ICL8069CCQ	3.11 B
INS8080A	5.50 B
DM8085	11.50 B
DM8121	.81 B
DM8124	1.60 B
DM8130	3.10 B
DM8131	3.05 B
8154	13.50 B
8155	9.85 B
8156	19.10 B
8205	4.35 B
P8212	2.63 B
I8212	2.85 B
N8233	1.98 B
8238	6.50 B
IP8238	7.50 B
8243	5.95 B
INS8245	4.65 B
INS8246	4.95 B
INS8247	8.67 B
8251A	7.25 B
8253	15.56 B
8255A	6.80 B
8257s-200	16.30 B
P8259A	12.97 B
D8279	13.75 B
8295	21.50 B
8303	1.20 B
DP8304	3.75 B
8414-250nS	12.00 B
8553	5.95 B
8554	5.95 B
DS8629	4.91 B
DS8678CAE	11.48 B
C8748	90.00 B
DS8820	1.98 B
DS8833	2.39 B
DS8836	1.35 B
DS8837	2.55 B
DS8881	5.88 B
S9900	49.00 B
S9902	5.95 B
MC10116L	.90 B
LM13088	1.15 B
LM13600	1.22 B
LF13741N	.52 A
LF13741H	.61 A
S50240P	5.35 B
AY-S-2376P	19.00 B
MM53200	4.46 B
MM58167N	12.53 B
MM5817 4	10.12 B
DS75107	1.55 B
DS75450	.57 B
DS75451	.57 B
DS75452	.46 B
DS75453	.45 B
DS75454	.45 B
DS754591N	.70 B
DS75492	.80 B
SN76001N	1.50 A
76477	3.28 B
SFF96364	41.76 B
91428	.46 B
MH0009CG	23.40 B

TRANSISTORS

2N301	3.05 A
2N657	.14 A
2N930	.61 A
2N1613	.90 A
2N1711	.81 A
2N2219A	.61 A
PN2222A	.18 A
2N2222A	.45 A
2N2483	.30 A
2N2484	.54 A
2N2646	.60 A
2N2647	1.03 A
2N2894	.68 A
2N2904	.43 A
2N2905	.53 A
2N2906	.39 A

TRANSISTORS (CONT)

2N2907	.38	A
2N2913	1.50	A
2N3019	.69	A
2N3053	.62	A
2N3054	1.20	A
2N3055	.55	A
2N3301	.25	A
2N3440	.86	A
2N3441	1.69	A
2N3502	.60	A
2N3503	.60	A
2N3563	.23	A
2N3564	.14	A
PN3565	.15	A
PN3566	.19	A
PN3567	.20	A
PN3568	.14	A
2N3569	.19	A
2N3568	.18	A
2N3568A	.20	A
2N3569	.18	A
2N3640	.18	A
2N3641	.18	A
PN3642	.15	A
PN3643	.14	A
PN3644	.18	A
PN3645	.20	A
2N3646	.24	A
2N3692	.28	A
2N3693	.30	A
PN3694	.20	A
2N3702	.26	A
2N3704	.18	A
2N3705	.18	A
2N3706	.18	A
2N3713	1.66	A
2N3731	5.76	A
2N3771	3.53	A
2N3772	2.85	A
2N3773	3.45	A
2N3819	.68	A
2N3866	1.60	A
2N3904	.20	A
2N3906	.20	A
2N4030	.88	A
2N4032	.78	A
2N4033	.78	A
2N4086	.82	A
2N4037	.73	A
2N4092	1.30	A
PN4121	.14	A
2N4235	1.55	A
2N4236	1.80	A
2N4248	.16	A
PN4249	.26	A
2N4250	.20	A
2N4258	.19	A
2N4292	.60	A
PN4342	.76	A
2N4354	.20	A
2N4355	.20	A
2N4356	.16	A
2N4360	.33	A
2N4398	4.38	A
2N4401	.14	A
2N4404	.23	A
2N4405	.20	A
2N4416	1.20	A
PN4888	.40	A
2N4906	2.45	A
2N5060	.53	A
2N5086	.22	A
2N5088	.14	A
2N5089	.21	A
2N5179	1.50	A
2N5190	1.15	A
2N5191	1.32	A
2N5195	1.67	A
2N5245	.65	A
2N5303	2.84	A
2N5320	.68	A
2N5401	.19	A
2N5408	.34	A
2N5459	.44	A
2N5461	.59	A
2N5484	.45	A
2N5485	.48	A
2N5486	.42	A
2N5550	.29	A
2N5589	4.65	B
2N5590	7.37	B
2N5591	8.57	B
2N5769	.14	A
2N5770	.23	A
2N5771	.28	A
2N5772	.28	A
2N5777	.75	A
2N5830	.22	A
2N5381	.25	A
2N5856	.27	A
2N5873	.94	A
2N5874	1.13	A
2N5885	2.68	A
2N5944	10.28	B
2N5946	17.19	B
2N5961	.24	A
2N5963	.90	A
2N6122	.62	A
2N6123	.59	A
2N6124	.62	A
2N6126	.62	A
2N6129	.63	A
2N6130	.70	A
2N6131	.77	A
2N6133	1.20	A
2SA353	.16	A
2SA354	.16	A
2SB187	1.00	A
2SC1060	1.45	A
2SC1061	1.45	A
2sc2166	1.59	A
2SK133	5.69	A
2SJ48	5.69	A
2SK134	7.34	A
2SJ49	7.34	A
3N201	.88	A
AC126	.51	A
AC127	.75	A
AC128	.67	A
AC187	.88	A
AC188	.88	A
AD149	1.96	A
AD161	1.16	A
AD162	1.16	A
AY6102	.50	A
AY6112	.50	A
AY6118	.50	A
AY6119	.50	A
AY6121	.50	A
AY8110	.50	A
AY8139	.64	A
AY9139	.64	A
B12-12	13.10	B
BC107	.23	A
BC107B	.28	A
BC108	.26	A
BC108C	.28	A
BC109	.25	A
BC109C	.27	A
BC147	.14	A
BC159	.14	A
BC177	.27	A
BC178	.31	A
BC179	.31	A
BC182A	.14	A
BC182L	.20	A
BC183L	.20	A
BC184L	.22	A
BC186	.47	A
BC204	.14	A
BC205	.14	A
BC206	.14	A
BC209	.14	A
BC212A	.14	A
BC212L	.20	A
BC213L	.20	A
BC214L	.20	A
BC287	.14	A
BC309	.16	A
BC317	.18	A
BC318	.14	A
BC319	.15	A
BC321	.14	A
BC322	.14	A
BC327	.12	A
BC328	.12	A
BC328B	.13	A
BC337	.11	A
BC338	.16	A
BC546B	.26	A
BC 547	.11	A
BC547A	.11	A
BC547B	.14	A
BC547C	.15	A
BC548	.08	A
BC548C	.15	A
BC549	.08	A
BC549C	.15	A
BC550	.12	A
BC557	.11	A
BC558	.08	A
BC558B	.14	A
BC559	.11	A
BC559C	.14	A
BC637	.28	A
BC638	.28	A
BC639	.35	A
BC640	.24	A
BCY70	.71	A
BCY71	.71	A
BD115	1.22	A
BD135	.48	A
BD136	.40	A
BD137	.42	A
BD138	.42	A
BD139	.39	A
BD140	.43	A
BD233	.48	A
BD234	.52	A
BD235	.43	A
BD237	.60	A
BD238	.49	A
BD262	.68	A
BD263	.66	A
BD301	.60	A
BD302	.60	A
BD433	.42	A
BD434	.44	A
BD435	.44	A
BD436	.46	A
BD437	.48	A
BD438	.48	A
BD439	.48	A
BD646	1.35	A
BD647	1.69	A
BD675	.70	A
BD678	.60	A
BD679	.62	A
BD680	.64	A
BD681	.66	A
BD682	.68	A
BDV64B	2.72	A
BDV65B	2.72	A
BDX64A	3.58	A
BDX64B	4.18	A
BDX65A	3.58	A
BDX65B	4.18	A
BDX66-P	8.64	A
BDX67B	9.50	A
BF115	.51	A
BF173	.70	A
BF180	.60	A
BF184	.50	A
BF195	.27	A
BF198	.22	A
BF199	.22	A
BF336	.68	A
BF337	.68	A
BF458	.82	A
BF469	.75	A
BF470	.87	A
BF494	.18	A
BFX29	1.02	A
BFX85	.63	A
BFX89	.98	A
BFY50	.78	A
BFY51	.78	A
BFY52	.69	A
BFY90	1.10	A
BSS68	.24	A
BSV17	.80	A
BSX20	.44	A
BU126	1.68	A
BU208	2.18	A
BU326A	1.92	A
BU426	3.54	A
BUX80	3.86	A
DX542CF	27.27	B
FT50	1.02	A
FT402	4.55	A
FT430	3.90	A
FT2955	1.22	A
FT3055	.96	A
MEL12	.70	A
MJ413	2.59	A
MJ802	2.99	A
MJ1001	1.90	A
MJE1091	2.45	A
MJ2955	.78	A
MJ4032	7.20	A
MJ4035	6.30	A
MJ4502	3.20	A
MJ15003	3.41	A
MJ15004	3.41	A
MJE340	.81	A
MJE350	1.50	A
MJE700	1.10	A
MJE800	1.02	A
MJE1100	1.84	A
MJE1101	2.10	A
MJE2955	.92	A
MJE3055	.92	A
MPF102	.45	A
MPF103	.57	A
MFE131	.93	A
MPSA05	.20	A
MPSA14	.24	A
MPSA42	.39	A
MPSA64	.45	A
MPSA70	.27	A
MPSA92	.43	A
MPSA4356		A
MPS6531	.45	A
MRF237	2.68	B
MRF238	12.27	B
MRF 450A	13.77	B
MRF454	31.22	B
MRF475	3.34	B
MRF901	1.88	B
OA675	.14	A
OC925	.14	A
OC9308	.14	A
OC955H	.31	A
OC9674	.31	A
PC208	.14	A
PE1010	.14	A
SE1002	.14	A
SE1010	.14	A
SE7055	.31	A
ST194	.14	A
TIP29A	.58	A
TIP29B	.63	A
TIP30A	.60	A
TIP30B	.63	A
TIP31A	.56	A
TIP31B	.60	A
TIP31C	.62	A
TIP32A	.56	A
TIP32B	.62	A
TIP32C	.79	A
TIP33A	.90	A
TIP33C	1.48	A
TIP34A	1.15	A
TIP34B	1.20	A
TIP34C	1.73	A
TIP41A	1.04	A
TIP42A	1.04	A
TIP42B	1.04	A
TIP42C	1.76	A
TIP110	.90	A
TIP115	.90	A
TIP120	1.17	A
TIP125	1.20	A
TIP127	1.18	A
TIP2955	1.06	A
TIP3055	.85	A
TT641	.12	A
U310	1.84	B
VMP4	24.90	B

DIODES

1N4001	.06	B
1N4002	.07	B
1N4004	.08	B
1N4007	.12	B
1N4148	.04	B
1N5060	.25	B
1N5404	.24	B
1N5408	.28	B
ST4/GT32	.22	B
P600G	.65	B
G.I.G.	.26	B
G.I.M.	.45	B
OA626-800	.52	A
BYX21L-400RI	.80	B
BYX21L-400	1.80	B
BYX21L-200	1.70	B
1N60	.08	B
1N914	.04	B
1S426	.10	B
ITT210	.10	B
BA102	.54	B
BA217	.04	B
BAV20	.30	B
MV104	.95	B
OA47	.30	B
OA90	.08	B
OA91	.15	B
OA95	.16	B
OA645	.14	B
MDA1010	1.00	B
BPW34	3.00	A
BPW50	1.50	A

BRIDGE RECTIFIERS

VM48	400v	1A DIL	.99	B
W02	200v	1.5A	.51	B
W04	400v	1.5A	.54	B
W06	600v	1.5A	.60	B
KBPC102	200v	3A	.98	B
KBPC602	200v	6A	1.86	B
KBPC604	400v	6A	2.00	B
KBPC606	600v	6A	2.20	B
KBPC1002	200v	10A	2.78	B
VJ448	400v	10A	3.15	B
KBPC1004	400v	10A	3.05	B
KBPC1006	600v	10A	3.29	B
PK40F	400v	12A	2.60	B
MDA3501	100v	35A	2.73	B
MDA3502	200v	35A	3.00	B
MDA3504	400v	35A	3.30	B
KBPC35	600v	35A	3.50	B

VOLTAGE REGULATORS

78L05	+5v	100mA	.38	B
79L05	-5v	100mA	.70	B
7805	+5v	1.5A	.86	B
LM309K	+5v	1.5A	1.76	B
7805K	+5v	1.5A	1.76	B
7905	-5v	1.5A	3.22	B
7905	-5v	1.5A	1.54	B
LM323K	+5v	3A	5.42	B
78H05	+5v	5A	7.10	B
78P05	+5v	10A	13.19	B
78L06	-6v	100mA	.38	B
7806	+6v	1.5A	.90	B
7906	-6v	1.5A	1.70	B
7808	+8v	1.5A	1.05	B
7908	-8v	1.5A	1.54	B
7808K	+8v	1.5A	2.45	B
78L09	+9v	100mA	.38	B
78L12	+12v	100mA	.38	B
79L12	-12v	100mA	.80	B
LM342-P12	+12	.25A	.67	B
LM341-P12	+12	.5A	.75	B
7812	+12v	1.5A	.86	B
7912	-12v	1.5A	1.50	B
7812K	+12v	1.5A	1.75	B
7912K	-12v	1.5A	2.99	B
78H12	-12v	5A	7.10	B
78CBUC	+13.8v	2A	1.98	B
78CBK	+13.8V	2A	4.90	B
78L15	+15v	100mA	.38	B
79L15	-15v	100mA	.85	B
LM342-P15	+15v	.25A	.67	B
LM341-P15	+15v	.5A	.75	B
7815	+15v	1.5A	.90	B
7815K	+15v	1.5A	2.97	B
7915	-15v	1.5A	1.70	B
7915K	-15v	1.5A	2.82	B
78H15	+15v	5A	7.10	B
78L18	+18v	100ma	.38	B
7818	+18v	1.5A	.90	B
7918	-18v	1.5A	1.70	B
7818K	+18v	1.5A	2.95	B
78L24	+24v	100MA	.38	B
79L24	-24v	100mA	.70	B
7824	+24v	1.5A	1.30	B
7924	-24v	1.5A	1.70	B
LM317T	+var	1.5A	1.45	B
LM337T	-var	1.5A	1.75	B
LM317K	+var	1.5A	2.66	B
LM337K	-var	1.5A	4.43	B
LM317 Hi+var		1.5A	5.11	B
LM337 Hi-var		1.5A	8.33	B
LM338K	+var	5A	5.75	B
78HGK	+var	5A	7.15	B
LM350K	+var	3A	5.75	B
79MG	+var	0.5A	1.32	B

SCRS

C106A	100v	4A	.60	B
C106F1	50v	4A	.60	B
C106B1	200v	4A	.64	B
C106B	200v	4A	.65	B
C106D1	400v	4A	.66	B
C106E1	500v	4A	.91	B
C106Y	30v	4A	.60	B
TIC46	100v	.6A	.65	B
EC103B	200v	.84A	.48	B
EC103D	400v	.84A	.53	B
S2003LS2	200v	3A	.60	B
Q6010LS5	600v	10A	1.60	B
S4016LS2	400v	10A	1.25	B
S6010L	600v	10A	1.55	B
S2015L	200v	15A	1.80	B
S4015L	400v	15A	2.00	B
S6015L	600v	15A	3.43	B

TRIACS

S2025H	200v	25A	3.10	B
S4025H	400v	25A	3.40	B
S4006LS2	400v	6A	1.15	B
C122D1	400v	8A	1.17	B
C122E	500v	8A	1.57	B
S6008L	600v	8A	1.65	B
S6025	600v	25A	8.19	B
S2035H	200v	35A	5.50	B
S4035H	400v	35A	6.95	B
S6035	600v	35A	9.22	B
S6035H	600v	35A	7.25	B
AC02DT	400v	2A	.50	B
Q6010LS	600v	10A	1.60	B
2N6073	400v	4A	.98	B
Q4004L4	400v	4A	1.05	B
Q2006L4	200v	6A	1.05	B
SC141D	400v	6A	1.00	B
Q4006L4	400v	6A	1.10	B
SC146D	400v	10A	1.45	B
Q4015L5	400v	15A	2.30	B
Q6015L5	600v	15A	2.90	B
Q4025H	400v	25A	5.50	B
Q6025H	600v	25A	6.75	B
Q4040D	400v	40A	8.64	B
Q4010L4	400v	10A	1.65	B
Q2015L5	200v	15A	1.98	B

LEDS+DISPLAYS

Red 5mm	.08	B
Green 5mm	.08	B
Yellow 5mm	.20	B
Orange 5mm	.20	B
MV5753 Red Wide beam	.34	B
MV5153 Orange Wide beam	.54	B
MV5353 Yellow Wide beam	.54	B
MV5752 Red Hi Intensity	.54	B
MV5352 Yellow Hi Intensity	.54	B
MV5152 Orange Hi Intensity	.54	B
MV5252 Green Hi Intensity	.54	B
LD271 Infra Red	.59	B
Green 3mm	.28	B
Red 3mm	.10	B
Yellow 3mm	.28	B
FND357cc 7-segment	1.55	B
FND358CA 7-segment	1.22	B
FND500cc "	1.20	B
FND507 CA "	1.39	B
FND800CC "	2.86	B
FND807CA "	2.86	B
MAN2A dot matrix	5.46	B
Red triangular	.21	B
Green "	.30	B
Yellow "	.30	B
ME7121 InfraRed Emit	1.65	B
ME7124 " "	1.65	B
ME8020 " Detector	.83	B
SEL351 Green 7-segment	.89	B
SEL151 Red "	.76	B
MAN54A .3" CC 7-seg. Gn	3.05	B
MAN72A .3" CA DL707	1.47	B
MAN74A .3" CC DL704	1.47	B
MAN84A .3" CC 7-seg Yel	3.05	B
MAN3620A .3" CA 7-seg Or.	3.05	B
MAN3640 .3" CC " Or.	3.05	B
MAN6640 .56" Or	4.65	B
MAN6660 .56" CA Or.	2.94	B
MAN6680 .56" CC Or.	2.94	B
MAN6740 .56" CC Red	3.17	B
MAN6760 .56" CA Red	2.03	B
MAN6780 .56" CC Red	2.03	B
MAN8610 .8" CA Orange	3.05	B
MAN8630 .8" CA "	3.05	B
MAN82A .3" CA Red	3.05	B
MAN8640 .8" CC Orange	3.05	B
LT303 .3" CC Red	1.30	B
LT302 .3" CA Red	1.30	B

Basic Electricity

AN INTERESTING 3 PAGES OF SIMPLE CIRCUITS TO TEACH YOU PARALLEL AND SERIES RESISTOR CONNECTIONS, OR TO BRUSH UP ON FORGOTTEN THEORY.....

THE ELECTRIC CIRCUIT

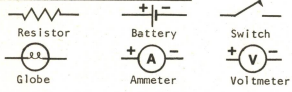
The term circuit in current electricity signifies the complete path through which an electric current passes.

Components needed to make a CIRCUIT:

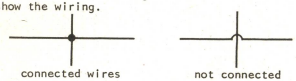
(a) A battery
(b) Conductors or wires to connect the battery to other circuit elements
(c) A load such as a globe, motor or resistor
(d) A controlling devise such as a switch
(e) A measuring instrument such as an ammeter or voltmeter

When drawing an electric circuit we represent each element by its symbol, which is a self-explanatory picture of the item. In the following electric circuits each item has a standard symbol.

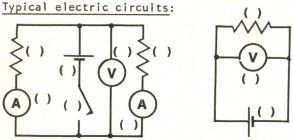
The following symbols are used:



These are connected together with lines to show the wiring.

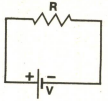


Typical electric circuits:

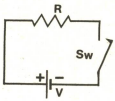


Fill in the brackets as follows:

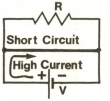
(a) A battery..... write (1)
(b) Conductor or wire..... write (2)
(c) A load: e.g. resistor... write (3)
(d) Controlling device..... write (4)
(e) Measuring instrument.... write (5)



Closed Circuit exists when a current flows through each element of the circuit as intended.



Open Circuit exists when there is a break of very high resistance in the circuit such as a switch or broken wire.



Short Circuit occurs when a high current flows through an incorrect path in preference to the circuit elements.

OHMS LAW

In any simple circuit we can determine the value of current flowing through a resistor by the following formula:

$$I = \frac{V}{R}$$

where I = current in amps
V = voltage across the resistor
R = resistance in ohms.

Ohms law can also be written:

$$R = \frac{V}{I} \quad \text{or} \quad V = I \times R$$

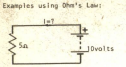
Note: When using the formula we must convert all our values to the basic units of volts, amps and ohms.

Thus:
200ma = 0.2 amps
3,000ma = 3amps
1kv = 1,000volts
2k2 = 2,200ohms
4M7 = 4,700,000ohms = 4.7×10^6

Convert the folowing to basic units:

(i) 5ma
(ii) 2,340ma
(iii) 10Kv
(iv) 3.47M
(v) 0.1Kvolts
(vi) 0.02Meg ohms
(vii) 5,300ma
(viii) 680ma

Examples using Ohm's Law:



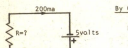
$I = \frac{V}{R}$

$= \frac{10}{5}$

$= 2amps$

What is the value of I?

Example 2.



Note: 200ma =.2amp

By Ohm's Law:

$R = \frac{V}{I}$

$= \frac{5}{.2} = \frac{50}{2}$

$= 25ohms$

Problems:

(a)

What is the current flowing in fig. (a)?

(b)

What is the value of 'Y'?

RESISTANCES IN SERIES

For resistances in series the total resistance is the SUM of their values.

e.g.

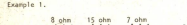
Total = 5 + 100 + 3

= 108 ohms.

In general:

$R_{total} = R_1 + R_2 + R_3 + R_4 \ldots\ldots$

Example 1.



What is the resistance between A and B?

Total resistance = 8 + 15 + 7

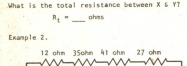
= 30 ohms.

Problem.

What is the total resistance between X & Y?

R_t = ___ ohms

Example 2.



What is the value of I?

Total resistance = 12 + 35 + 41 + 27

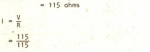
= 115 ohms

$I = \frac{V}{R}$

$= \frac{115}{115}$

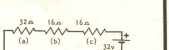
$= 1 amp$

Problem:



What current is flowing in the circuit?

In a series circuit such as:



The voltage across each resistor can be found from:

$E_{(a)} = I \times R_{(a)}$

where I is the same for the three resistors in a series circuit.

Current flowing:

$I = \frac{E}{R} = \frac{32}{64} = 0.5 amp$

$E_{(a)} = I \times R(a)$

$= 0.5 \times 32$

$= 16 volts$

Question: What is the voltage across each 16 ohm resistor?

RESISTANCES IN PARALLEL

For resistors in parallel the equivalent single resistance if found from the following equation.

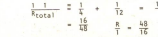
$\frac{1}{R_{total}} = \frac{1}{R_1} + \frac{1}{R_2} + \frac{1}{R_3} + \ldots\ldots$

Example 1.

$\frac{1}{R_{total}} = \frac{1}{4} + \frac{1}{12} = \frac{12+4}{48}$

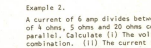
$= \frac{16}{48}$ $\quad \frac{R}{1} = \frac{48}{16} = 3$ ohm

This shows that two parallel resistors can be replaced by a single resistance of 3 ohms.



Example 2.

A current of 6 amp divides between resistances of 4 ohms, 5 ohms and 20 ohms connected in parallel. Calculate (i) The voltage across the combination. (ii) The current flowing in each resistor.



Let R be equivalent resistance.

$\frac{1}{R} = \frac{1}{4} + \frac{1}{5} + \frac{1}{20}$

$= \frac{5+4+1}{20}$

$= \frac{10}{20}$

$\frac{R}{1} = \frac{20}{10} = 2$ ohms

Now: from Ohms Law, the voltage across the resistors:

$V = I \times R$

$= 6 \times 2 = 12$ volt

The voltage of 12volt appears across each resistor.

Current flowing in 4 ohm resistor:

$= \frac{V}{R} = \frac{12}{4} = 3$ amps

Current in 5 ohm resistor:

$= \frac{V}{R} = \frac{12}{5} = 2.4$ amps

Current in 20 ohm resistor:

$= \frac{V}{R} = \frac{12}{20} = 0.6$ amps

Problems:

COMBINED PARALLEL & SERIES CIRCUITS

What is the resistance between A & B?

Resistance of a Parallel combination:

$\frac{1}{R} = \frac{1}{100} + \frac{1}{200}$

$\frac{1}{R} = \frac{3}{200}$

$\frac{R}{1} = \frac{200}{3} = 66\frac{2}{3}$ ohms.

Total resistance between A & B

$= 50 + 66.6$

$= 116.6$ ohms.

Example:

What is the resistance between X & Y?

Resistance of 50ohm + 100ohm combination = 150 ohms

Circuit becomes:

$\frac{1}{R} = \frac{1}{200} + \frac{1}{150}$

$= \frac{3+4}{600}$

$\frac{R}{1} = \frac{600}{7}$

$= 85\frac{5}{7}$ ohms

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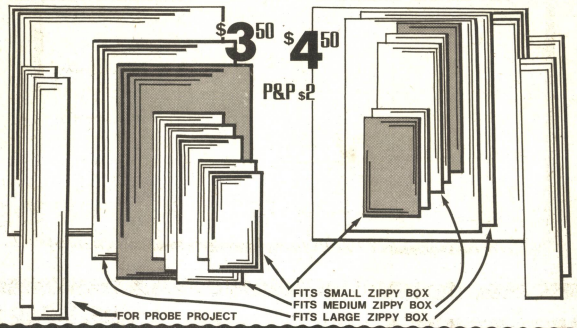

HELP!! It doesn't work!

Don't forget, all the projects in the magazine are guaranteed to work. If they don't; don't despair! Try a little friendly persuasion on the circuit, check and double check everything. Ask a frlend...get a little technical advice. If all this fails, try sending it to the man who designed it. Try sending it back to the magazine. For $3 we will look over your effort and try to get it going. If it is made on one of our PC boards, it will have a lot more hope. To avail yourself of this service, send the unit in a jiffy post bag size '00' with $3 plus $1 for any parts it may require, together with your name and address and a few words about the fault. Incl 80c in stamps for return postage. We like these little teasers as they help us up-date our projects for the next issue.

Vero battery box

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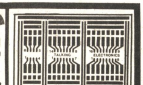
vero / vero STRIP



$1.85

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VEROBOX large 6.80
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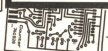
" small 1.95

No. 60 Drill: 85c



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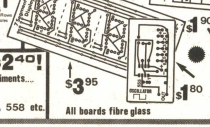
PCBs $1.80

20 Transistors $2.40!

As used in 'THE TRANSISTOR PAGE' experiments....
ALL NEW! ALL GUARANTEED! HURRY!
TYPICAL TYPES: BC 547, 548 BC 557, 558 etc.



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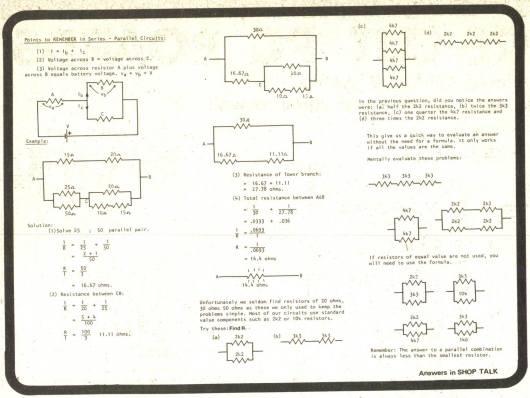
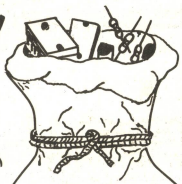

Points to REMEMBER in Series - Parallel Circuits:
(1) I = I1 + I2.
(2) Voltage across B + voltage across C.
(3) Voltage across resistor A plus voltage across B equals battery voltage. V1 + V2 = V.
Example:
Solution:
(1) Solve 25 ; 50 parallel pair.
(2) Resistance between CB:
= 16.67 ohms.
(3) Resistance of Tower branch:
= 16.67 + 11.11
= 27.78 ohms.
(4) Total resistance between AB
= 10 + 27.78
= .0333 + .036
= 18.9 ohms
Unfortunately we seldom find resistors of 22 ohms, 30 ohms 50 ohms so these we calculate. To make problems simple, most of the circuits use standard value components such as 2k2 or 10k resistors.
Try these: Find R.
In the previous question, did you notice the answers were: (a) half the 2k2 resistance, (b) twice the 3k3 resistance, (c) one quarter the 9k7 resistance and (d) three times the 2k2 resistance.
This give us a quick way to evaluate an answer without the need for a formula. It only works if all the values are the same.
Mentally evaluate these problems:
If resistors of equal value are not used, you will need to use the formula.
Remember: The answer to a parallel combination is always less than the smallest resistor.
Answers in SHOP TALK

PARTS BY THE Kgm!!



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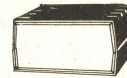

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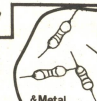

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TCA 335, 540, 750.
TDA 2523, 2560, 2581, 2590, 2591, 2660.
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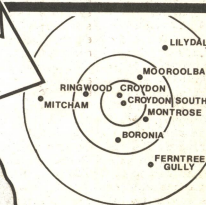


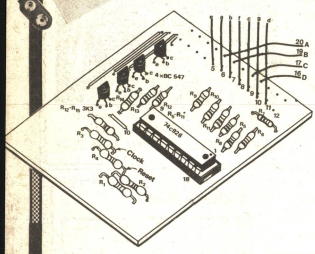
Ian J.
Truscott Electronics
Cnr. Bayswater and Eastfield Rds
Sth. Croydon
723-38[illegible]

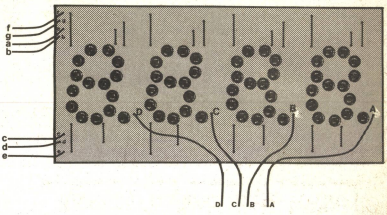
Connecting the

COUNTER MODULE TO 7-Segment Display

— Craig Jones

Project cost: $12 +$10





2.5cm READOUT

If you require a large display, one which can be read from a distance of 3 - 15 metres, you can combine the COUNTER MODULE with the 7-SEGMENT DISPLAY. We have provided Molex pins on the PC board to enable the "AND" display to be easily removed and replaced by any display of your choice. When it is removed, the connections between the two boards are made via flying leads, fitted into the holes 5 to 11 and 16, 17, 19, 20. The Molex pins are best removed as they are not very rigid and can be bent over and create a short to the next-door pin. We need 2 widths of rainbow cable to connect the home-made 7-segment display to the counter. One lead contains 4 wires, the other 7 wires. The first cable fits into holes 16, 17, 19, 20 and connects directly to the cathodes of the digits A,B,C,D. The other cable fits into holes 5,6,7,8,9,10,11 and connects to the segment rails a,b,c,d,e,f,g. To keep the wiring simple we have not included any decimal points. The 7-segment letters appear at the end of the PC board and run the length of the display to link up with each digit via jumpers on the board. The 7 core ribbon will need careful wiring at the display end as the lettering on the display does not correspond directly with the module and will have to be criss-crossed before soldering to the lands. The other end of the ribbon cable will need to be prepared by tinning before soldering into the PC board holes.
The diagram shows which pins correspond to the segment outputs and which pins provide the digit outputs.

Mounting

Lay the assembled display on to P19 of issue 2 and you will find it fits neatly into a Zippy box type UB3. (What a handy idea, having the full range of box sizes for reference!)
The lid of the UB3 box should be replaced by a thin sheet of red perspex to highlight the illuminated LEDs and completely camouflage the other LEDs. The red screen improves the clarity of the illuminated display immensely. Glue plastic standoffs onto the display and mount it just behind the perspex screen with silicone sealant. Bring the rainbow ribbon out the side of the box. This lead can be as long as needed so the readout can be mounted at any distance and any height depending on its intended use.
You can also use 12-core Telecom wire for this interconnection. (Available from Dick Smith Cat. W 2140).

If you experience difficulty obtaining the 74C926, you can substitute it directly with two other chips. They all have identical pin-outs. But they do not give the same counting up to 9999 as they are designed for slightly different purposes. However these differences may fall in line with your requirements. The maximum readouts of the three IC's are as follows:

74C926:	9999
74C927:	9599
74C928:	1999

You will notice the 74C927 is designed to be used as an elapsed timer. The first digit indicates hours, the next two digits give minutes and the fourth digit indicates tenths of a second.

THE DYNAMIC ALTERNATIVE

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Max Input Voltage	600VP-P or 300V(DC+AC peak)
Sensitivity:	250mV/DIV, or better
Bandwidth:	DC-500K(Hz)-3dB)
Input Impedance:	1MΩ±10% Within 35PF
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Linearity: Synchronizing:	Less than 5% Internal and external

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R2708	.0047 MFD	20c	18c	12c
R2710	.0056 MFD	20c	18c	12c
R2714	.0068 MFD	20c	18c	12c
R2716	.0082 MFD	20c	18c	12c
R2718	.01 MOS	20c	18c	12c
R2720	.015 MFD	20c	18c	12c
R2722	.022 MFD	20c	18c	12c
R2724	.033 MFD	20c	18c	12c
R2726	.039 MFD	20c	18c	12c
R2728	.047 MFD	20c	18c	12c
R2730	.056 MFD	20c	18c	12c
R2732	.068 MFD	20c	18c	12c
R2734	.082 MFD	20c	18c	12c

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R3215	4.7 MFD	35V	25c	20c
R3220	6.7 MFD	63V	25c	20c
R3230	10MFD	25V	25c	20c
R3235	10MFD	35V	25c	20c
R3240	10MFD	63V	25c	20c
R3245	15 MFD	25V	30c	25c
R3250	15 MFD	63V	30c	25c
R3255	22 MFD	25V	30c	25c
R3260	22 MFD	35V	30c	25c
R3265	33 MFD	25V	40c	35c
R3270	33 MFD	35V	40c	35c
R3275	47 MFD	25V	50c	45c
R3280	47 MFD	35V	50c	45c
R3310	470 MFD	6V	1.10	95c
R3315	1000 MFD	6V	1.50	1.30
R3320	1000 MFD	16V	1.50	1.30
R3325	1000 MFD	25V	1.80	1.50
R3327	2500 MFD	16V	1.80	1.50
R3330	2500 MFD	25V	1.90	95c
R3380	2500 MFD	35V	2.10	1.80
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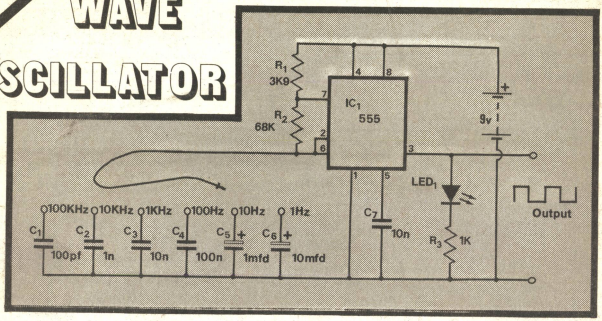


SQUARE-WAVE OSCILLATOR CIRCUIT

The heart of our circuit is a 555 timer. It is capable of precision timing and has drift values somewhat better than its surrounding parts! We have seen the 555 timer before but a re-cap of its versatility and characteristics will be invaluable if you wish to alter the circuit. Using a 555 produces an inexpensive project which is self-contained and can be connected and finished or partly finished project you wish to test. We have tried to obtain a decade readout between each frequency using standard components to give a 10:1 increase with each stage. This gives a universal coverage suitable for slow clocking through to a fairly high operational speed. The advantage of a slow clock from an oscillator in preference to a switch means the elimination of bounces and spikes.

The layout of the board lends itself to the addition of any special frequency you may choose or merely provide a selection of two or three frequencies. It all depends on how many capacitors you include. At a slow clock rate, this oscillator will help you determine if an IC is clocking on the rising edge of the waveform or the falling edge. This knowledge is essential when designing a circuit with a number of IC's which are required to be in synchronisation from one clock source. If you don't understand these terms, wait for issue 5.

The project can be mounted in a small Zippy box to protect it from rough handling. When connecting the battery, you will need to add a switch as the 555 draws about 10ma during quiescent conditions. The LED draws about 8ma or about 4ma average on a 50% duty cycle waveform, making a total of about 15ma. The frequencies are selected via a flying lead that fits into one of 6 molex pins. This saves expensive switches and keeps the project compact.

Timing periods are virtually independent of rail voltage. They are set by the time taken for the timing capacitor to charge to 2/3 of the supply voltage then discharge to 1/3 of the supply voltage and recharge to 2/3 the supply voltage again ad infinitum. Since the 68k resistor is the main resistor controlling this charging and discharging, we can see that these two periods will be almost equal. (The fact that the 3k9 is added to the 68k during charging will make very little difference to the charge time.) To understand how the 68k charges and discharges the capacitor, we must look into the operation of the 555 IC. When the supply is connected, the capacitor begins to charge. When its voltage rises to 2/3 of the supply voltage, this is detected by pin 6, transferred to the comparitor inside the IC, to connect pin 7 to the negative rail. This causes the capacitor to discharge through the 68k resistor to a point where it is 1/3 of the rail voltage. Pin 2 detects this, removes the short on pin7 to allow the capacitor to charge up again.

555 NOTES

Here are some helpful notes for future circuit designing.

The output of the 555 is capable of sourcing (supplying) a maximum current of 200ma and can sink (absorb) the same current.
This makes it suitable for driving loads such as relays and LEDs without the need for a buffer transistor. In the astable (or free-running) mode as shown in the circuit diagram, the 555 triggers itself and the timing capacitor charges through R_1 and R_2 and discharges through R_2 only. By adjusting these resistors, the duty cycle can be precisely set.

The Duty cycle "D" is given by:

$$D = \frac{R_b}{R_a + 2R_b}$$

Putting **R** values into the formula

we obtain: $\frac{68,000}{3900 + 136,000}$

$$= \frac{68}{139.9}$$

$\therefore$ **D** = 50%

In this formula, you can see the top resistor R_a has such a low value with respect to R_b that it has very little effect on the duty cycle.

The frequency of oscillation of the 555 timer follows this formula:

$$f = \frac{1.44}{(R_a + 2R_b)C_1}$$

If we take the values for the slow clock rate and insert them into the formula,

we obtain:

$$f = \frac{1.44}{(3900 + 136,000)10\times10^{-6}}$$

$$= \frac{1.44}{1.399 \times 10^5 \times 10 \times 10^{-6}}$$

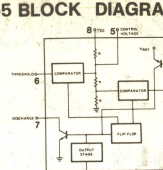
$$= \frac{1.44}{1.399}$$

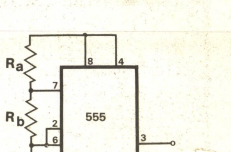
= approx 1Hz

555 PIN-OUT

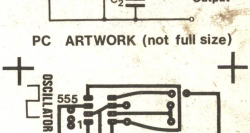
1 Ground
2 Trigger
3 Output
4 Reset
5 Control Voltage
6 Threshold
7 Discharge
8 V_{cc}

555 BLOCK DIAGRAM





PC ARTWORK (not full size)



PARTS LIST

R1	resistor	3k9 ¼watt
R2	"	68k "
R3	"	1k "
C1	capacitor	100pf 100v
C2	"	1n "
C3	"	10n "
C4	"	100n "
C5	electrolytic	1mfd 16v
C6	"	10mfd "
C7	capacitor	10n 100v
LED_1	3mm or 5mm	Red LED
IC_1	TIMER	NE 555
battery snap		6 molex pins
9v battery		hook-up flex
hook-up wire		IC socket

"SQUARE WAVE OSCILLATOR PC BOARD"

DECIMAL NUMBER:	BINARY NUMBER:
0	00
1	01
2	10
3	11
4	100
5	101
6	110
7	111
8	1000
9	1001
10	1010
11	1011
12	1100
13	1101
14	1110
15	1111
16	10000
17	10001
18	10010
19	10011
20	10100
21	10101
22	10110
23	10111
24	11000
25	11001
26	11010
27	11011
28	11100
29	11101
30	11110
31	11111
32	100000
33	100001
34	100010
35	100011
36	100100
37	100101
38	100110
391	100111
40	101000
41	101001
42	101010
43	101011
44	101100
45	101101
46	101110
47	101111
48	110000
49	110001
50	110010
51	110011
52	110100
53	110101
54	110110
55	110111
56	111000
57	111001
58	111010
59	111011
60	111000
61	111101
62	111110
63	111111

.....Continuing the

EXPERIMENT

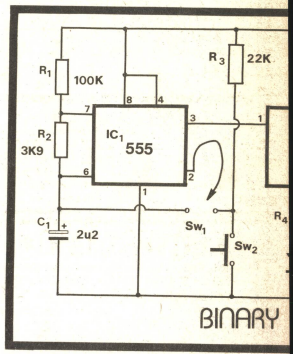
BINARY C

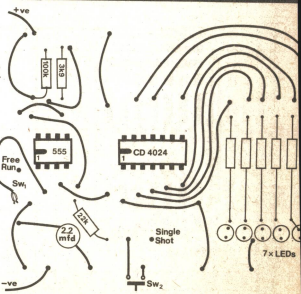
A BASIC 7-STAGE COUNTER TO TEACH BINARY. DOUBLES AS A VISUALLY EYE-CATCHING DISPL

PROJECT SEVEN

The next stage in this series involves learning the Binary Table. You may ask, "What is the necessity of a Binary Table?" What's wrong with our 0-9 numbering system? The answer is quite simple. Digital electronics produces voltages which are either HIGH or LOW. They are not designed to give "half-on" or "quarter-off" situations as these are indeterminate values. How would you tell when the output of a circuit is half ON and not 45% ON? Digital electronics is in essence an exact science. There are no "in-between" voltages. Under these conditions the circuit will be suitable to drive a LED accurately. The LED will respond by being either fully ON or completely OFF. This means a LED can never be half ON, so visual interpretation will not be required to read the value. The LEDs in the output of our circuit are required to represent numbers. We could do this in two ways: Allocate one LED for each number if we wish to count up to 20 or 30, however a very large display would be created if we wished to count to 100 or 500. Another, and more practical, method is to program the LEDs to represent a particular value when lit. The simplest method of achieving an easily readable display has already been designed. It is called a BINARY DISPLAY. The word binary is derived from BI- meaning 'two', and each LED is designed to be read in either of its two reliable states: ON or OFF.

Suppose we set up a row of 7 LEDs. As with ordinary columns of numbers, the digit in the right-hand column represents the smallest number or "units". The same applies with the BINARY TABLE. When this LED is off, it represents zero. When illuminated it represents ONE. To represent TWO, the next LED will light and the first LED will be OFF. Obviously a three will require both LEDs to be ON. Using two LEDs we can count to only three. The next LED will represent a FOUR. This allows us to count to seven. (1 plus 2 plus 4). The binary system uses more readouts than conventional decimal notation however it is a form which can be directly coupled to an electronic circuit to see exactly what is happening within. Can you imagine trying to interpret a LED which is supposed to be illuminated 40%? This would be absolutely impossible as LEDs give off varying intensities according to their batch number or quality rating. Luckily this does not concern us in the BINARY TABLE





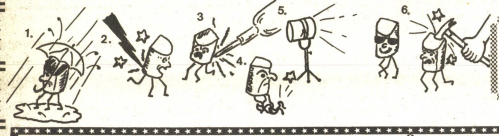
JUNIOR PUZZLE PAGE

This page provides the very beginning into ELECTRONICS. You can't get anything more simple. Any contributions for this page will be welcome.

CAN YOU SEE ANYTHING WRONG WITH WITH THIS SENTANCE?

PROTECTING TRANSISTORS:

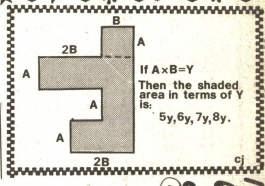
Match these words to the 6 diagrams: HIGH VOLTAGE, HEAT, MECHANICAL SHOCK, MOISTURE, INCORRECT BIAS, BRIGHT LIGHT.



If a transistor costs a dollar and a half, and you get half a transistor change, what is the cost of 3 transistors?

The border of this page is made up of capacitors and diodes. But there is one small mistake. Can you find it?

Here is a puzzle I found among some old papers: A radio is built onto a narrow printed circuit board. The three major sections are: THE FRONT END, IF STAGE, and POWER AMPLIFIER. The front end is 8cm long. The power amplifier is as long as the front end and half the IF stage. The IF stage is as long as the front end and power amplifier together. What is the length of the radio strip?



ELECTROWORD

P. Watt 3154

FIND THE HIDDEN ELECTRONIC WORDS. THEY MAY BE SPELT VERTICALLY, HORIZONTALLY, BACKWARDS OR DIAGONALLY. HERE IS A LIST OF THE WORDS:

AND	DATA	INVERTER	OR
BATTERY	DIGITAL	LED	OUTPUT
CAPACITOR	DIODE	NAND	RESISTOR
CHIP	ELECTRONICS	NOR	TALKING
CIRCUIT	INPUT	NOT	TRANSISTOR

Z	O	Y	N	X	I	O	T	P	C	I	R	C	U	I	T	Y
D	C	A	N	D	N	D	P	A	A	T	E	O	T	T	I	E
B	F	Y	A	X	M	O	A	O	R	E	O	S	N	I	D	E
O	E	O	N	E	G	A	N	T	I	N	V	E	R	T	E	R
A	T	E	D	K	B	O	S	N	A	N	C	A	T	A	O	O
T	A	L	K	I	N	G	O	O	B	O	T	H	O	T	T	Y
A	L	E	O	E	O	N	O	R	Z	T	I	O	I	I	O	R
E	T	C	O	B	Y	A	N	O	E	I	E	P	I	P	O	E
E	E	T	N	Y	A	M	R	O	T	S	I	S	N	A	R	T
T	I	R	E	E	D	O	I	D	Z	A	I	O	A	E	E	T
U	E	O	Y	D	O	I	K	B	I	B	A	S	E	O	A	A
P	N	N	O	A	G	O	G	L	Y	L	O	R	T	A	R	B
N	I	I	H	E	A	T	S	I	N	K	N	O	T	O	O	A
I	N	C	H	O	U	T	P	U	T	I	A	Z	A	M	R	Z
G	I	S	C	O	G	U	E	O	E	A	K	O	U	Y	A	C
R	O	T	I	C	A	P	A	C	D	E	L	Z	B	G	O	A

Can you decode this noisy picture: ?

TALKING ELECTRONICS
A New Magazine for Experimenters

POWER SUPPLY

PARTS LIST:

Parts for PC board:

1 - 39R ¼watt
1 - 150R "
1 - 270R "
1 - 470R "

1 - 500R trim pot

1 - .1mfd 100v
1 - 2500 25v

4 - EM401
1 - 7805 regulator
1 - 5mm red LED

Enclose $3.50 plus $1 P&P.
All other parts from your local electronics supplier.

WAVE OSCILLATOR

PARTS LIST:

1 - 1k ¼watt
1 - 3k9 "
1 - 68k "

1 - 100pf
1 - 1n
2 - 10n
1 - 100n

1 - 1mfd 16v
1 - 10mfd "

1 - 5mm red LED

1 - 555 IC

battery snap
6 molex pins
hook-up flex

Enclose $2 plus 60¢P&P.

BINARY COUNTER

PARTS LIST:

7 - 680R ¼watt
1 - 3k9 "
1 - 22k "
1 - 100k "

1 - 2.2mfd 16v

1 - NE 555 IC
1 - CD 4024 IC

7 - 5mm red LEDs

battery clip
switch
molex pin
hook-up wire

See also EXPERIMENTER BOARD Circuits 1-5

Enclose $3.45 plus 60¢ P&P.

COUNTER MODULE

7 - 100R ¼watt
7 - 180R "
7 - 220R "
7 - 270R "
7 - 330R "
4 - 3k3 "
4 - 1M "

4 - BC 547

1 - 74C926 IC

1 - AND 4145R display

Enclose $15.50 plus $1 P&P.

TALKING ELECTRONICS
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7 SEGMENT DISPLAY

FOR ONE DIGIT:
15 - 3mm Red LEDs

enclose $1.50 plus 60¢ P&P.

FOR FOUR DIGITS:
60 - 3mm Red LEDs

enclose $6.00 plus 60¢ P&P.

LIGHT THE LED

PARTS LIST:

2 - 22k ¼w
2 - 2k2 "
1 - 1k "

1 - BC 547

1 - 4.7mfd 10v

6 - 1N 4148

1 - Red 5mm LED

1 - CD 4017 IC

1 - Battery clip

1 - Springy brass strip

Enclose $3.00 plus 60c P&P.

LED ZEPPELIN

PARTS LIST:

1 - 270R ¼w
1 - 330R "
1 - 390R "
3 - 470R "
1 - 560R "
3 - 1k "
2 - 2k2 "
1 - 3k3 "
1 - 4k7 "
1 - 10k "
1 - 22k "
1 - 56k "
1 - 470k "

1 - 4.7mfd 16v
1 - 470mfd 16v
7 - BC 547
1 - BC 557

1 - CD 4001 IC

6 - Large red LEDs
1 - Mini red LED

2 - 1N 4148
1 - Push-on switch
1 - battery clip

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TALKING ELECTRONICS
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EXPERIMENTER BOARD

PARTS LIST:
For circuits 1-5

1 - 1k ¼w
1 - 2k2 "
1 - 10k "
1 - 100k "

1 - .01mfd ceramic
1 - .1mfd ceramic
1 - 10mfd electro 10v

1 - 555 IC
1 - CD 4017 IC

1 - PE cell ORP12
or similar
2 - Red LEDs
1 - Push-on switch
1 - battery clip

Enclose $5.30 plus $1 P&P.

Circuit 6:

2 - 10M ¼w
1 - 1mfd 16v
1 - BC 557
6 - 5mm Red LEDs
30cm hook-up wire

Enclose $1.05 plus 60¢ P&P.

Circuit 7:

7 - 680R ¼watt
1 - 3k9 "
1 - 22K "
1 - 2.2mfd 16v
1 - CD 4024 IC
7 - 5mm red LEDs

Enclose $2.80 Plus 60c P&P.

EXPERIMENTER DECK

Projects 1 - 10

1 - CD 4001 IC
1 - CD 4017 IC

1 - 15R ¼w
1 - 22R "
1 - 120R "
1 - 3k3 "
2 - 4k7 "
5 - 10k "
1 - 47k "
1 - 100k "

1 - 1n 100v
1 - 3n3 "
1 - 3n9 "
3 - 6n8 "
2 - 22n "

1 - 4.7mfd 10v
1 - 22mfd 10v

6 - 1N 4148 diodes

1 - 100k cermet VTP
1 - 500k " "

24 - Red 5mm LEDs
1 - Green 5mm LED

1 - BC 557
3 - BC 547

1 - 24" spkr 8 or 15Ω

30cm of 10-core ribbon
30cm tinned copper wire
Roll of fine solder

Enclose $11.50 plus $1 P&P.

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Parts for PC board:

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1 - 2500 25v

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1 - 7805 regulator
1 - 5mm red LED

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All other parts from your local electronics supplier.

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1 - 3k9 "
1 - 68k "

1 - 100pF
1 - 1n
2 - 10n
1 - 100n

1 - 1mfd 16v
1 - 10mfd "

1 - 5mm red LED

1 - 555 IC

battery snap
6 molex pins
hook-up flex

Enclose $2 plus 60¢P&P.

BINARY COUNTER

PARTS LIST:

7 - 680R ¼watt
1 - 3k9 "
1 - 22k "
1 - 100k "

1 - 2.2mfd 16v

1 - NE 555 IC
1 - CD 4024 IC

7 - 5mm red LEDs

battery clip
switch
molex pin
hook-up wire

Enclose $3.45 plus 60¢ P&P.

Same PCB as EXPERIMENTER BOARD Circuit 1 - 7

COUNTER MODULE

7 - 100R ¼watt
7 - 180R "
7 - 220R "
7 - 270R "
7 - 330R "
4 - 3k3 "
4 - 1M "

4 - BC 547

1 - 74C926 IC

1 - AND 4145R display

Enclose $15.50 plus $1 P&P.

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FOR ONE DIGIT:
15 - 3mm Red LEDs

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FOR FOUR DIGITS:
60 - 3mm Red LEDs

enclose $6.00 plus 60¢ P&P.

LIGHT THE LED

PARTS LIST:

2 - 22k ¼w
2 - 2k2 "
1 - 1k "

1 - BC 547

1 - 4.7mfd 10v

6 - 1N 4148

1 - Red 5mm LED

1 - CD 4017 IC

1 - Battery clip

1 - Springy brass strip

Enclose $3.00 plus 60c P&P.

LED ZEPPELIN

PARTS LIST:

1 - 270R ¼w
1 - 330R "
1 - 390R "
3 - 470R "
1 - 560R "
3 - 1k "
2 - 2k2 "
1 - 3k3 "
1 - 4k7 "
1 - 10k "
1 - 22k "
1 - 56k "
1 - 470k "

1 - 4.7mfd 16v
1 - 470mfd 16v
7 - BC 547
1 - BC 557

1 - CD 4001 IC

6 - Large red LEDs
1 - Mini red LED

2 - 1N 4148
1 - Push-on switch
1 - battery clip
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EXPERIMENTER BOARD

PARTS LIST:
For circuits 1-5

1 - 1k ¼w
1 - 2k2 "
1 - 10k "
1 - 100k "

1 - .01mfd ceramic
1 - .1mfd ceramic
1 - 10mfd electro 10v

1 - 555 IC
1 - CD 4017 IC

1 - PE cell ORP12
or similar
2 - Red LEDs
1 - Push-on switch
1 - battery clip

Enclose $5.30 plus $1 P&P.

Circuit 6:

2 - 10M ¼w
1 - 1mfd 16v
1 - BC 557
6 - 5mm Red LEDs
30cm hook-up wire

Enclose $1.05 plus 60¢ P&P.

Circuit 7:

7 - 680R ¼watt
1 - 3k9 "
1 - 22K "
1 - 2.2mfd 16v
1 - CD 4024 IC
7 - 5mm red LEDs

Enclose $2.80 Plus 60¢ P&P.

EXPERIMENTER DECK

Projects 1 - 10

1 - CD 4001 IC
1 - CD 4017 IC

1 - 15R ¼w
1 - 22R "
1 - 120R "
1 - 3k3 "
2 - 4k7 "
5 - 10k "
1 - 47k "
1 - 100k "

1 - 1n 100v
1 - 3n3 "
1 - 3n9 "
3 - 6n8 "
2 - 22n "

1 - 4.7mfd 10v
1 - 22mfd 10v

6 - 1N 4148 diodes

1 - 100k cermet VTP
1 - 500k " "

24 - Red 5mm LEDs
1 - Green 5mm LED

1 - BC 557
3 - BC 547

1 - 2½" spkr 8 or 15Ω

30cm of 10-core ribbon
30cm tinned copper wire
Roll of fine solder

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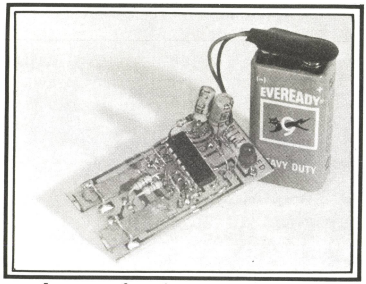
Issue No1.

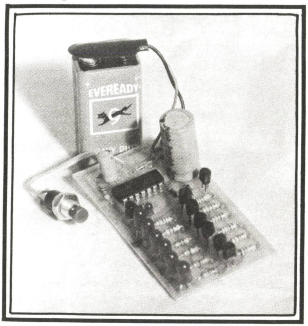


A game of patience...

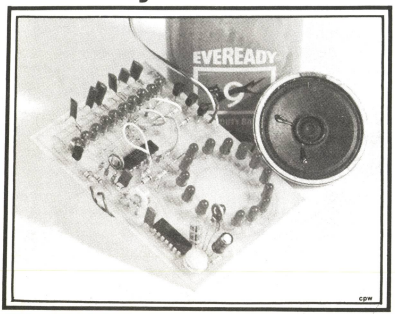
Light the LED

LED Zeppelin

A game of skill...



10-Projects-in-1



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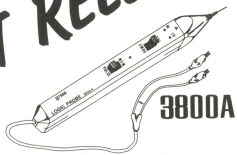

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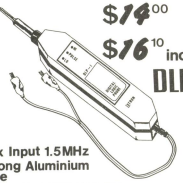
Smart black plastic case
53cm leads



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Max Input 1.5MHz
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KEY to LEDs on back of probe
Input Impedance 300k

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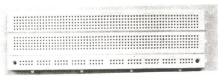

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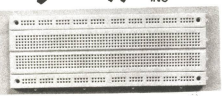

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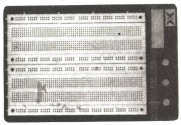

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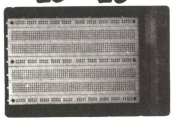

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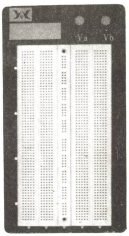

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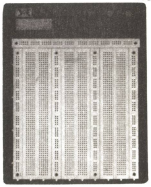

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EACH ISSUE WILL FEATURE A PROJECT ON THESE BREAD BOARDS

CJ

TALKING ELECTRONICS

Vol.1 No.1

Welcome!

TALKING ELECTRONICS originates its name from the synthesised speech modules currently being incorporated into electronic games. These modules can speak hundreds of understandable words and will cause a revolution in electronics. In a few years a complete talking project will consist of one chip , a battery and switch – just like the calculator I bought last week. It contained no parts other than an MPS 7560 IC!

We want you to be ahead in the talking electronics field but to learn how these chips work you must begin at basics. This means making simple projects and becoming involved. This magazine will hep you do just that. To benefit you must promise me two things:

1. To build a project each issue.
2. Answer the quiz questions.

Only this way will you improve your knowledge of electronics to build the more complex projects in the future.

Good experimenting,

Colin Mitchell.

Editor

PUBLISHER

TALKING ELECTRONICS MAGAZINE is designed by Colin Mitchell and published at 35 Rosewarne Ave., Cheltenham. 3192. All material is copywright however up to 30 photocopies for clubs and schools is allowed. Bulk purchase may be cheaper than photocopying.

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31	5W W.W. RESISTORS	5% 4R, 5R, 6R, 8R, 10R, 12R, 15R, 18R, 20R, 22R, 27R, 33R, 39R, 47R, 56R, 68R, 82R, 100R, 120R, 150R, 180R, 220R, 270R, 330R, 390R, 470R, 560R, 680R, 820R, 1K, 1K2, 1K5, 1K8, 2K2, 3K3, 3K9, 4K7, 5K6, 6K8, 8K2, 10K, 12K, 15K, 18K, 22K, 27K, 33K, 39K, 47K, 56K, 68K, 82K, 100K, 120K, 150K, 180K, 220K, 270K, 330K, 390K, 470K, 560K, 680K, 820K, 1M, 1M2, 1M5, 2M2, 3M3, 3M9, 4M7, 5M6, 6M8, 8M2, 10M	ea	.45c	2nd	46c

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RED LED	small 3mm	20c	16c	12c
RED LED	std. 5mm	16c	14c	12c
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LM380	2watt IC	$1.50	$1.30	$1.20

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OPEN 7 DAYS

LIGHT THE LED

A game of patience.
Using just two switches, a pre-programmed combination has been set for this counting IC. I challenge anyone to break the combination within 30 minutes and repeat it!

Project cost: $5

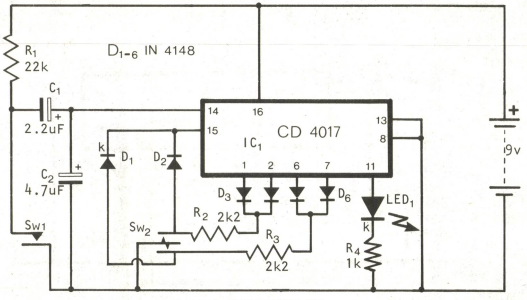


Fig. 1 **LIGHT THE LED**

Here is an ideal project if you are looking for something different in electronics. Many times I have wished I had an electronic brain teaser to try out on a witty friend or some small present to take to a sickie in hospital. Well here it is. Most of the games available on the market are too expensive or complex while others can be unravelled in a few minutes. With this game I think I have provided an ideal challenge. I like things which look easy but prove to be difficult.

The secret combination (actually it should be called permutation) is locked into the game's CD 4017 IC via the gating diodes D_3 D_4 D_5 and D_6 so that when any of the outputs go high, the switch Sw_2 must be in a position so that it earths the signal and prevents it resetting the IC via either diode D_1 or D_2 (which feeds the reset pin 15). The object of the game is to light the red LED. With only two switches this looks at first to be an easy matter. Why, you may think, "I'll just have to push the switches randomly a few times and eventually I must strike the right combination." Well, chances are you won't, and secondly, you will not be able to repeat your effort again if you did happen to strike it after hours of trial.

I would prefer to give you no clues at all on solving the combination however you will need to test the unit and thereby I lose my strategy. Without divulging too much I'll release two small clues. 1. Connecting the battery resets the IC. 2. The first switch (called the "clocking" switch) must be pushed nine times in total and

COMPONENTS YOU WILL NEED:

R_1 resistor 22k ¼ watt 5%
R_2 resistor 2k2 ¼ watt 5%
R_3 resistor 2k2 ¼ watt 5%
R_4 resistor 1k0 ¼ watt 5%
C_1 electrolytic 2.2 mfd 10v
C_2 electrolytic 4.7 mfd 10v
$D_1 - D_6$ 1N 914 or 1N 4148
LED_1 Light Emitting Diode
IC_1 counter IC CD 4017
.01" thick springy brass strip
Battery Clip
9v Battery
"Light the LED" PC Board

light the led

the second switch must be pushed twice. May I suggest you try random selections for 30 minutes to satisfy yourself that even with two major facts known, the combination is still securely locked into the puzzle. After tiring of this, settle down and compile a table showing all the possible combinations. Using this table will remove repetitive operations and you will most probably light the LED.

red LED. This may look simple but believe me, if someone handed you the finished project and asked you to decipher the combination you would be at a loss completely. I have another project at a later date in which the timing is absolutely critical and yet another which has high cycling on each switch, so an outsider doesn't know which variables are important and it is left for him to show his ability.

The output pins turn on and off sequentially according to this pin order: 3-2-4-10-1-5-6-9-11. This can be quite confusing as it is not in order of the pin numbering on the IC! This unfortunate sequence has come about in the designing process and it sometimes makes printed circuit construction very difficult. For this project I have used some of the printed circuit as a platform for the switches. Utilizing the copper as a base makes the switch rigid and integral with the board and saves about $1. By using the PC board upside down the IC and the parts can be mounted on top of the solder-lands quite easily. There is no need to drill any holes and this is an additional saving. The third and most important reason for using an undrilled board is the ease of removing the parts once the project is no longer required. I hope this will never be the case!

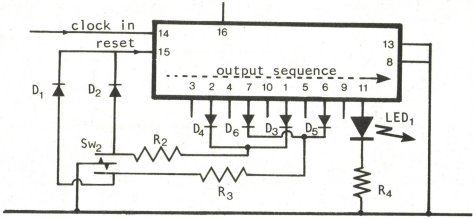


Fig. 2 Circuit showing the output sequence.

HOW DOES IT WORK?

Fig. 1 gives you no idea of the operation of the circuit. I have drawn it this way for two reasons. Firstly, it makes the circuit very simple (which it is) and secondly, if someone asks you to see the circuit to try and work out the combination, he will be completely lost.

Connecting the battery will reset the counter so that output pin 3 will have a high voltage on it. Pressing the "clock" switch Sw_1 will make pin 3 go low and pin 2 high. The high will pass through D_4 and into the 2k2 load R_2 if switch Sw_2 is in the up position. If Sw_2 is pressed at any time pin 2 is in a high state, the voltage will pass through D_2 and reset the counter back to pin 3. There are four such hidden reset paths which have to be correctly manipulated for the signal to make 9 jumps and finally light up the

The main reason we draw the IC as a vacant block (apart from simplifying the schematic) is due to the manufacturer rarely releasing the circuitry. Of those schematics which have been released the circuitry is so complex that it would fill up an entire page of this magazine. The internal workings of an IC is of little importance to us. We are mainly concerned with the function of each pin and the overall capability of the little 14 pin wonder. We can let you into a little more detail, however, and reproduce all the IC pins to show how the 10 outputs are turned on and off one at a time, each time the input pin is "clocked". Clocking means applying a pulse to the input pin 14.

Should you wish to "borrow" the IC at a latter date for another project all you need do is sit the board upright, hold the ends of the IC with your fingers and run the soldering iron down a row of pins. This will make the IC come partly off the board and by running the iron down the other pins the IC will come away cleanly. What a contrast to removing an IC from a normal PC board. Usually it's an almost impossible task without a solder sucker or desoldering iron and plenty of patience.

light the led

MOUNTING THE PARTS

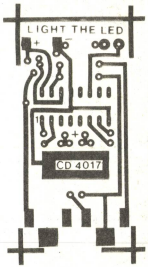
The two switches are fabricated. This means you will be making the switches yourself from two pieces of springy brass and two saddles cut from resistor wires. Cut two pieces of brass 2.5cm long x .7cm wide (1" x ¼") from .010" brass sheet. Tin one end of each strip and solder it onto the large copper land on the printed circuit board. Make sure they are parallel to each other and come right down to the bottom edge of the board. Curve them upwards so they have a 1cm travel to the PC board. Make two staple-looking saddles from wire cut off a resistor and trim the legs short so that when you place them over the brass strips they press fairly hard on the brass. Solder them in position making sure the strips still have some travel left to touch the printed circuit contacts below. Dimple the centre of each saddle to make a point contact. Mount all the other components as shown in the layout diagram except the two top diodes D_1 and D_2. These will be soldered in after the unit has its pre-test. The other diodes and resistors can be left standing up from the board to reduce congestion. Hold each part in your fingers as you solder it. If you find the parts getting too hot, you are taking too long to solder them. This is the easiest way to judge if you are good at soldering.

Here are three tips to speed up your soldering:

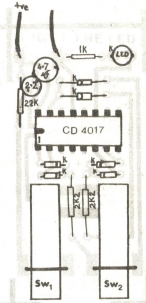
1. Tin each lead of the component first. This is a must. I always do this before soldering any parts into a project.
2. Use only a fine tip soldering iron. Preferably use a constant temperature soldering iron for fine work like this.
3. Use FINE solder. Old fashioned 16 and 18 gauge solder is OUT.

TESTING THE UNIT

All the parts should be soldered in place as shown in the diagram except the two top diodes D_1 and D_2. Connect only their cathodes (marked with a band) to pin 15. Connect the other end of D_1 via a jumper lead to the negative lead of the battery. The reset pin must not be left open or floating as this will prevent the IC from clocking. Connect a 9v battery to the battery clip. Push Sw_1 ten times and the LED will light up. Try this a number of times. You are cycling the Decade Counter. Notice you must push the switch slowly and firmly as any contact bounce will register on the IC very easily and the LED will light up after pushing the switch only 6, 7 or 8 times. A considerable amount of contact bounce has been eliminated by the inclusion of the 2.2mfd and 4.7mfd electrolytics. Without them the bounce from five pushes will register as a count of ten. Disconnect the battery and solder D_1 into circuit Connect the battery and cycle the counter via Sw_1 The LED should not light up even after 50 pushes. If it does light up, Sw_2 is not making connection at its upper contact. Press Sw_2 down any cycle the IC. After each ten clocks the LED should light up. Disconnect the battery and solder D_2 onto the board. Make sure Sw_2 lower contact is working by soldering a bump of solder onto each surface and cleaning with a small file. Now try to light the LED!



FULL-SIZE LAYOUT DO NOT drill the board. All the parts are mounted on the copper side.



MAKE YOUR OWN PC BOARDS

It's fun
It's economical

Making your own Printed Circuit Boards is fun and economical and I can almost guarantee you will get a perfect result. I have never lost a board yet and if a mistake occurs you can remove it from the board and start again. This article may seem technical and complicated but after reading it through twice and at least attempting the procedure, you find it impossible to get good results, I will give you a refund out of my own pocket! This is how foolproof I think it is. The procedure is about as complicated as making a cake and requires no special tools. There is one kit available containing all the chemicals you will need or most of them can be bought separately from large electronics shops or Dick Smith Stores. Here is a list of the items I bought:

1 blank fibreglass board 150mm x 75mm (6" x 3")	H5540	$1.45
1 blank fibreglass board 150mm x 150mm (6" x 6")	H5545	$2.90
1 bottle positive resist CCPR12	H5720	$3.75
1 bottle positive developer crystals CCPD16	H5724	$1.85
1 bottle Ferric Chloride etching solution	H5652	$1.90
post & pack		$3.50
TOTAL:		$15.35

I also bought a complete kit of parts from EXPERIMENTER PARTS CO, which contained a smaller quantity of the above chemicals and a few extra necessary components. This is what the kit contained:

5 small blank PC boards ranging from 40mm x 75mm to 100mm x 75mm
1 plastic bag containing cleaning powder
1 small bottle of positive resist, enough for 10 boards
1 packet of developer crystals, enough for 10 boards
1 bottle of ferric chloride solution for 10 boards
1 No 60 drill

Complete kit $7.00 P & P $2.00

Note: The two main chemicals CCPR12 and CCPD16 are a product of Circuit Components of Bexley NSW and carry their code, namely: Circuit Components Positive Resist 12 or CCPD16.

The following notes are compiled from my experience in making "one-off" boards for the magazine using instructions supplied with the chemicals. I have updated the instructions slightly to make them a little simpler to understand.

GENERAL

CCPR12 Photo Resist is a positive working Polyvinyl compound which, when exposed to ultra violet light through an artwork made from dense black tape and circles, on a clear or translucent film, will leave the black areas as a pattern on the laminate when developed. The clear or translucent area exposed to ultra violet light will break down and wash away during development leaving an image which will offer strong resistance to a veriety of etching solutions. This process uses "contact printing" and requires size/size artwork such as that found in magazines or from Talking Electronics Magazine Art Dept.

ITEMS YOU WILL NEED

A small oven or frypan which can be set at 90°C(194°F)
2 small plastic trays - similar to those from take-away food shops
1 small paint brush 3cm (1")
2 small wooden sticks - similar to ice-cream sticks
1 sheet of glass - enough to cover the PC board
plenty of paper towels
1 new piece of CHUX Superwipe or CHUX nappy-liner
1 kit of chemicals as per above list

PREPARATION

The kitchen sink is an ideal place for preparing the boards as it is near the oven, has plenty of running water and is not exposed to direct sunlight. Place the chemicals on a WHOLE newspaper and use plenty of water whenever the chemicals are splashed. The chemicals will not attack your fingers harshly however the Ferric Chloride and Resist will stain.

LAMINATE PREPARATION

Select a board larger than the required size so that an allowance of at least ¼" is left all round. Clean the board with the cleaning powder or use Ajax or Bon Ami. Add a few drops of water to the powder and rub well into the board with your finger then finish with a slightly damp Chux superwipe cloth. (Do not use sponge-type kitchen pads or STEEL WOOL, due to their ability to hold grease).
Hold the scrubbed laminate under running water and be sure the copper surface "wets" evenly all over. If a break appears in the surface tension of the water, rescrub and re-test. Dry both sides with a clean piece of paper towel, being particularly careful not to touch the prepared surface of the laminate with the fingers. (Skin oils will contaminate the surface and nullify the preparation). Then brush the surface with a soft clean brush to free the surface of lint and dust. The finished laminate must be dust free for best results.

COATING THE LAMINATE

Pour a small pool of resist in the centre of the prepared laminate and thinly smooth over the surface with a 3cm paint brush. (Use a NEW brush and keep it for use with the resist only). Wash brush in Methylated Spirits, then in soap and water. A"streaky" appearance when wet usually settles down during the drying process. An equally successful method is to pour a little resist on the board and tilt it to flow all over the board. Allow excess to drip off. The coating should be of medium density. Too thick gives difficult drying/developing, too thin could result in "pin holing".

OVEN TEMPERATURE

This is a critical stage in the process. The oven temp/time combination must be correct. The CCPR12 resist cannot be air dried at ambient temperature due to some of the solvents requiring high temperature to remove them. The shelf should be set in the centre of the oven and the oven pre-heated to 80°C(176°F) or 90°C(194°F). When up to temperature, place the coated laminate on the shelf and allow to bake for 10 to 12 minutes. For a small laminate, a FRYPAN may be used if set up in the following manner: Place a wire grid such as a cake cooling stand (see I told you it's as easy as baking a cake) in the frypan. Set the control to 340° on the thermostat. Open the vent in the vent in the lid and set the lid on the frypan furthest from the thermostat side. Place a piece of scrap laminate flat between the lid and base at the thermostat side to allow a ventilation air flow. Let this arrangement stand, turned on for approx 25 - 30 minutes to preheat. Once it has completely warmed up, switch the frypan off and place the board inside and bake for 10 - 12 minutes. Be sure to replace the lid as described above.

Note: It is recommended that ovens using exposed or infra-red elements NOT be used as the red colour rays may prevent the photo sensitivity from functioning. Where these and gas ovens are employed, bring the oven up to temperature and switch off, then place the prepared laminate in the upper section of the oven for 15 to 20 minutes.

ARTWORK

The printed circuit artwork should be on film for best results however drawings from magazines or good photocopies will work provided they have no black printing on their reverse side. Place the artwork face up on the copper side of the board and tape in position. Place the sheet of glass over this and also tape in position.

EXPOSING

This stage is fairly critical. Two types of exposure are ideal:

1. UV LAMPS. Two 20 watt Sylvania type F20T12-BL fluorescent tubes (or Philips Actinic Blue fluorescent tubes, both makes being 3,900 Angstroms) are mounted on a twin batten unit. This should be positioned 3cm (1") from the PC board and requires an exposure verying according to the artwork.
   Typically these are: 2 minutes for clear film
   4 minutes for matte film
   8 mins for magazine page

2. DIRECT SUNLIGHT. This is the cheapest and works very well. Pick a bright sunny day.
   The exposure times will be:
   4 minutes for clear film
   5 minutes for matte film
   8 minutes for magazine page

Note: Suntan lamps can be used but are not recommended. Safelights are not needed. The entire operation can be carried out in LOW LEVEL incandescent ambient light. Special dark-room facilities are not essential, but keep clear of direct or reflected sunlight, fluorescent or red lighting. When using double-sided material, make up a stand using 1cm thick particle board with four 2-inch nails protruding through, just outside the artwork area but smaller than the PC board. Coat both sides of the laminate and stand it on the nail points. Place it in the centre of the oven. When dry, clamp the laminate and both artworks between two sheets of glass and expose each side in turn. Develop both sides at once.

DEVELOPMENT

To 300 ml of water (½ pint) add one heaped teaspoon (10 gm) of CCPD16 Developer Crystals. This will be enough for 10 small PC boards. The next stage is the MOST IMPORTANT step of the whole job.
Immerse the exposed laminate in the developer and move it about in the solution gently

avoiding splash, I suggest a wooden stick or better still, use a clip to keep full control. In a few seconds the image will appear. Keep washing away the resist for a few more seconds until it has been removed from the unwanted areas. Watch carefully that the pattern doesn't start to disappear too! Take the board out and wash it under running water. If you make a mistake you can dip it back into the developer or even wash it all off and start again.
Notes: If, in the prebaking stage, the oven was not up to temperature, the image will appear very quickly and then wash away completely. On the other hand, if the baking were overdone, the strength of the developer may be increased very slightly by dissolving more crystals in the solution. (Remove the coated laminate FIRST). If this is done, be careful not to use for subsequent boards which may have been baked correctly. This developer is not flammable but should be treated with care as should all chemicals. Always wash from hands or other exposed skin as soon as possible after contact. Rinse the developed laminate under running water and dry off with a cloth, then allow to cool in free air for 30 minutes to stabilize.
Post bake at 100°C (212°F) for 30 minutes is recommended. Allow the laminate to fully cool before etching.

ETCHING

Three forms of Ferric Chloride are available:

1. YELLOW LUMP (Hydrated) Mix 200gm (7oz) with 200ml of water in the plastic tray and stir until dissolved.
2. ANHYDROUS Mix 100 gm with 300ml of cold water. Note: Add the powder to the water slowly stirring continuously as this process will generate extreme heat.
3. FERRIC CHLORIDE SOLUTION 42% Mix 50ml (1/5th bottle) with 100ml of water.

AMMONIUM PERSULPHATE Dissolve 100gm in 250ml of water. This solution should be heated to 40°C(100°F) but not above 50°C(120°F) for etching. Form a "basket" of plastic tubing and use a continuous "dunking" action until fully etched. Constant agitation is essential and a fresh solution should etch in 5 to 7 minutes. This is a particularly clean etchant but does not etch as much area as the same volume of Ferric Chloride.

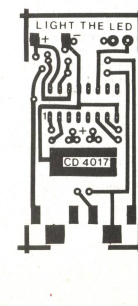
The Ferric Chloride solution should be pre-warmed by immersing the tray in warm water for 10 minutes. Place the board in the solution and rock gently. Remember, the etching is faster with agitation and you should be able to see immediately where the copper is being eaten away. Keep rocking and watching the process. It should take about 10 minutes to completely etch through the copper sheet and you will see the green of the fibreglass begin to show through. By holding the board up to the light you will see when it is finished. Wash the board under running water. If some of the copper has been left in unwanted places within the artwork area, it can be removed by using a brush or stick containing some developer, to remove the resist. In some cases I have replaced it into the developer to remove the final traces of unwanted resist without losing the copper-lands. The board is then placed in the ferric chloride solution for final etching.
It's a fun process and most gratifying. I hope you enjoy it as much as I do.

WARNING

Exercise caution when using chemicals. Do not smoke. Do not use the resist, thinners or methylated spirits near naked flame and on no account use any utensil which has been used with chemicals for food or drinking purposes. Good housekeeping is essential for good results - keep all utensils clean and dust free.
Note; The resist is not a flux, however it does not hinder soldering and can be left on the board to keep the soldering neat and professional-looking. Use fine cored solder when making up the circuit as this has plenty of flux. Pack away all the chemicals after use. The developer should be placed in an air-tight jar where it will last for many months.

SUMMARY

- Turn on oven
- Clean laminate
- Coat laminate with resist
- Turn off oven
- Bake laminate for 10 mins
- Heat Ferric Chloride solution
- Fix artwork and laminate to glass
- Expose in sunlight for 5 mins
- Remove resist in developer 5 secs
- Wash board
- Etch board in Ferric Chloride solution
- Wash board
- Drill all holes with No 60 drill



Start with this....

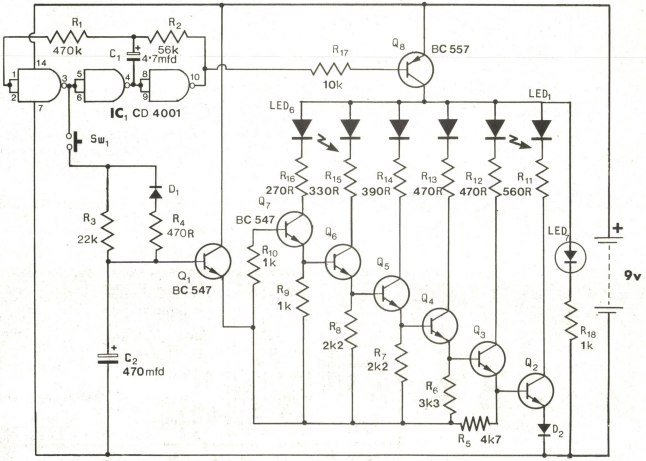
ANSWER TO LIGHT THE LED

Switch on. IC will reset. Left hand button: clock; clock. Right hand button down and kept down while: clock; clock. Right hand button up: clock; clock; clock; clock; clock. Red LED will glow.

LED ZEPPELIN

Led Zeppelin is a game of patience. It's like getting a kite into the air. It goes up slowly but the slightest mistake will bring it down like a lead balloon.

PROJECT PRICE
Approx: $8.00



LED ZEPPELIN

Our game name,LED ZEPPELIN, is a play on words. It comes not from the pop group but from Graf Von Zeppelin, a german army officer who invented the first rigid air ship in 1900. The association fits perfectly with this project.

The game consists of six LEDs which flash at 2 cycles per second. A push button is the "Operations Control" and by carefully pushing the button in synchronization with the flashes, the row of LEDs will gradually light up but the slightest mistake will immediately extinguish one, two or three LEDs.

HOW THE CIRCUIT WORKS

The circuit consists of a three-inverter CMOS clock oscillator driving Q_8 which flashes the LEDs on and off. The other output from the oscillator is used to charge up the 470mfd electrolytic C_2, via R_3. The output from pin 3 is in the form of a square wave only slightly less than the supply voltage and is about 7.5v to 8v. The frequency of oscillation is governed by R_1, R_2 and C_1 and is approximately 2Hz. Charging of the 470mfd electrolytic is exponential so that initially the voltage

increments on the capacitor will be greatest when it is beginning to charge. Each time the button is pressed a small amount of energy is fed into C_2. This voltage appears at the base of Q_1 which is connected as an emitter-follower and the voltage will appear proportionally at the emitter, less the .6v base-emitter voltage drop of Q_1. This voltage is then fed to the base of six transistors Q_2 to Q_7 which drive LEDs 1-6 via current limiting resistors. Each of these transistors will turn on according to the voltage on the 470mfd electrolytic. As the voltage rises to .6v, Q_1 will turn on. For Q_2 to turn on its base must be .6v highet than the emitter. Now Q_2 has a forward-biased diode in its emitter lead and the voltage drop across it will be .6v. The base of Q_2 must be .6v above the emitter, making it .6 plus .6 or 1.2v This means the voltage on C_2 will be .6v plus .6v plus .6v or 1.8v for the first LED to be fully lit. The emitter of Q_3 is connected to the base of Q_2 so that a further .6v will turn it on. At each successive .6v rise the next transistor in the chain will turn on until finally Q_7 will switch on. This transistor drives the top LED which is the highlight of the game. When you have LED 6 pulsating you really feel a sense of achievement. Should the button be pressed when the oscillator is low, the diode D_1 is forward biased and the charge on C_2 will rapidly discharge through R_4. Since the voltage increments become smaller as the 470mfd becomes fully charged, to light the top LED requires significantly more pushes than LEDs 1 and 2. If, however, the button is pushed too long, the discharge will be greatest when the capacitor is nearing full charge and an error here will lose the gain made by many pushes. This is where the skill of the game comes in.

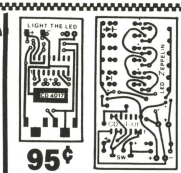
The charging of the capacitor is "out of phase" with the flashing of the LEDs. This means the button must be pressed when the LEDs are extinguished. To turn the game off, push the button when the LEDs are lit. This will remove the charge on C_2 and eventually every LED will go out.

CONSTRUCTION

All the components are mounted on the Printed Circuit Board. Follow the layout diagram for the identification of each part. You will notice all the components are placed neatly on the board with Q_2 - Q_7 fitted the same way around and all LEDs mounted the same way. For the transistors a dot on the PC board signifies the collector lead. Both electrolytics are identified with their positive lead. The IC has pin 1 shown and the switch connections are also identified.

verocraft

VERO STRIP — $2.00 ea.



$1.85↑

$1.50 undrilled
$1.80 drilled

$3.40 undrilled $3.75 drilled

All boards fibre glass

No. 60 Drill: 85c

HELP!! It doesn't work!

All the project in the magazine are guaranteed to work and we will help you get it working for a small fee.

For $3 we will look over your project and hopefully get it going provided it is on one of our printed circuit boards. Send the project wrapped in tissue in a jiffy padded post bag size '00' with $3 plus $1 for possible damaged parts together with your name and address and a few words about the fault and 80¢ in stamps for return postage.

20 Transistors $2.40!

As used in 'THE TRANSISTOR PAGE' experiments....
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TYPICAL TYPES: BC 547,548 BC 557, 558 etc.

TV service transistors!

BU 126 $2.20
BU 208 $2.80

TALKING ELECTRONICS mag,
35 Rosewarne Ave.,
Cheltenham 3192.

Post & Pack:
1 board 60c
others 25c ea.

PARTS LIST

R1	resistor	470k ¼watt 5%
R2	"	56k "
R3	"	22k "
R4	"	470R "
R5	"	4k7 "
R6	"	3k3 "
R7	"	2k2 "
R8	"	2k2 "
R9	"	1k0 "
R10	"	1k0 "
R11	"	560R "
R12	"	470R "
R13	"	470R "
R14	"	390R "
R15	"	330R "
R16	"	270R "
R17	"	10k "
R18	"	1k0 "

C1 electrolytic 4.7mfd 16v
C2 " 470mfd 16v

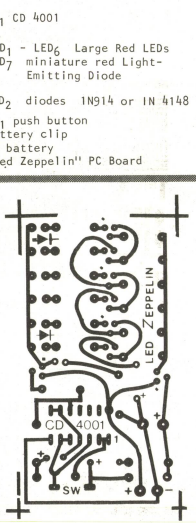
Q1 - Q7 transistors BC 547
Q8 " BC 557

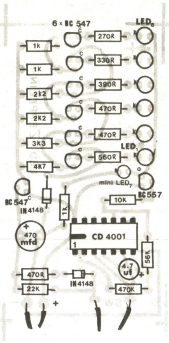
IC_1 CD 4001

LED_1 - LED_6 Large Red LEDs
LED_7 miniature red Light-Emitting Diode

D_1D_2 diodes 1N914 or IN 4148

Sw_1 push button
battery clip
9v battery
"Led Zeppelin" PC Board



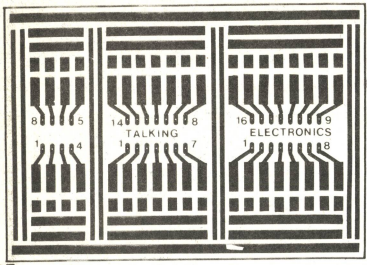


The last two items to connect are the two wires for the switch and the battery clip. Check all soldering and the orientation of the transistors. I always connect a milliammeter in one battery line whenever I switch on a project for the first time to check if a short-circuit is present or excessive current is being drawn - you should do this if you have a multimeter.

TO PLAY

The miniature LED begins to flash when the battery is connected. This indicates the flash rate. To start the chain of LEDs flashing, push the switch a number times when the LED is extinguished and eventually you will see the first LED flash faintly. Keep in harmony with the off periods and you will gradually increase the illumination. The rest is up to you.

The LED ZEPPELIN game can be played a number of ways. The most popular is to count the number of pushes required to get the top LED flashing with reasonable brightness. The player with the least number of pushes wins. Another variation is to cover the six LEDs with black tape leaving just the indicator LED flashing. The object of the game is to see how many LEDs can be set flashing with a certain number of pushes. Start with 50 pushes per player. Push the button 50 times then remove the tape and read your score. You can make certain adjustments such as 3½ or 2½ LEDs flashing. When used competitively, like this, the game provides a means of assessing your reflex time and co-ordination.



Designed for:
TALKING ELECTRONICS

INTRODUCING THE....

BOARD PRICE:
$1.85

PROJECT PRICE
Approx:
$2ea.

A PC board you can use again and again.....

This series of articles is designed around the TALKING ELECTRONICS IC EXPERIMENTER BOARD. This PC board is made for these 3 IC's:
8 pin IC
14 pin IC
16 pin IC

All the components including the IC's are mounted on TOP of the board. This type of construction is called "bread-boarding" and has 3 major advantages for the experimenter:

1. The board can be used again and again.
2. The parts – including the IC's – can be easily removed.
3. The board is very easy to use – it doesn't have to be turned over to follow the copper tracks.

All this adds up to an inexpensive way to produce quick projects which can be transferred to a home-made PC board if the circuit needs to be kept or made to look more professional, if not they can be removed.

The IC EXPERIMENTER BOARD has been specially designed for newcomers unaccustomed to soldering integrated circuits or in fact anyone wishing to use the same components in future projects. The .1" matrix which is now universally used for all electronic components has been enlarged a little to make soldering easier. This is why the solder lands for the IC's have been spread out from the socket. Interconnection between IC's has been provided by the double copper tracks at the top and bottom. The extreme outside tracks from the positive and negative rails.

You shouldn't have any difficulty following the simple projects in this series. The layout diagrams will help you to position the parts accurately.

USING IC's

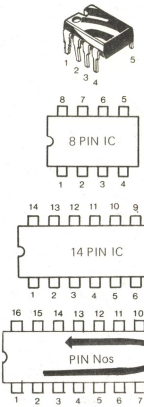
For those who have never handled IC's, there are basically two types of IC which we will be using in these projects. The older type called TTL stands for Transistor-Transistor-Logic. They are quite robust and can be soldered into circuit without any fear of damaging them provided you keep your fingers on the body of the IC as a heat-sink while soldering the pins.

The second type is CMOS, standing for Complementary-Metal Oxide Semiconductor. These types are sold to you with their leads fitted through tin-foil to prevent any static electricity build-up damaging their input gates. Once you remove the foil, solder them into circuit making sure the IC is heat-sinked with your fingers.

PIN NUMBERING

All IC's are numbered in an anticlockwise direction when looking at them soldered onto a printed circuit board. Pin 1 is identified by either a keyway or notch in the end of the IC or a dimple near the pin. Don't take any notice of any other holes, they are just push-pin holes created when the IC is pushed out of its manufacturing cavity.

Pin numbering is always ANTICLOCKWISE



16 PIN IC

Boards are available from:
TALKING ELECTRONICS Magazine
(See Advert)

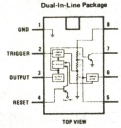
EXPERIMENTER BOARD

THE 555 TIMER

One of the handiest IC's to be invented is the 555 timer. It is contained in a tiny 8 pin package and consists of a complex array of transistors which only need a few external components to produce an accurate time delay.

555 BLOCK DIAGRAM

In this diagram you can see a free-running flip-flop which is triggered via pins 2 and 6 to drive the output pin 3. The 555 timer can provide time delays ranging from several minutes for one cycle of operation to many



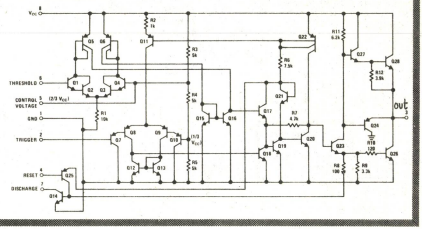
thousands of cycles per second. Any circuit which cycles more than a few times per second is called an oscillator. Below this frequency we cay it is "cycling". The frequency of oscillation is measured in cycles per second (cps) – now called Hertz (Hz) in honour of the scientist H.R. Hertz 1857-94 who experimented with electromagnetic waves which he called hertzian or radio waves – thus the name Hertz.

Only two external resistors and one capacitor are needed to provide timing for the 555 timer. The output can drive a load such as a LED which will flash each time the timer is cycled.

FULL 555 SCHEMATIC

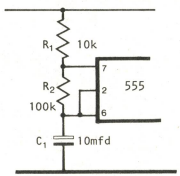
The full schematic diagram is reproduced here mainly to show its complexity. Obviously it would not be worthwhile making this circuit from individual components as the whole chip costs less than 40 cents! It incorporates 28 transistors and a set of resistors housed inside the 8 pin package. The schematic can be simplified somewhat to a block diagram making the operation of the circuit slightly easier to understand.

schematic diagram



HOW DOES THE 555 TIMER WORK?

The 555 timer operates by sensing voltage levels on pin 2 and 6.



TIMING COMPRISES R_1 R_2 & C_1

When the IC is connected to the supply, the capacitor C_1 begins to charge. When its voltage rises to 2/3 of the supply voltage, pin 6 detects this level and turns the IC off. The pin is then effectively disconnected from the circuit and does not have any further function until the IC is turned back on again. At the same instant pin 7 becomes connected to the negative rail via circuitry inside the IC so that the capacitor begins to discharge via R_2. As this occurs, the voltage on pin 2 is reducing to a point where it becomes 1/3 of the supply voltage. Pin 2 detects this and turns the IC on again. It removes the short on pin 7 so that the capacitor C_1 can charge up again. During this charging period pin 2 has no effect on the charge-time as it is virtually disconnected.
In summary: the IC triggers between two voltage limits to turn the LED on and off.

PROJECT ONE

flashing LED

One of the simplest and most effective circuits using the 555 timer is a low frequency oscillator driving a LED. In this first project the components have been chosen to give a frequency of about 2 cycles per second (2Hz). This means the LED will blink twice per second.

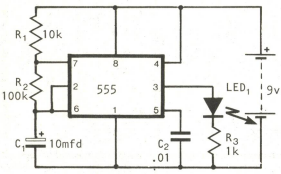
The whole circuit uses just 7 components. These are soldered onto the top of the experimenter board as shown in the layout diagram. You will need 7 jumper wires to connect the IC pins to the parts via the copper tracks. Use a 9v battery to power the LED and connect the battery snap to the positive and negative tracks as shown.

Before connecting the battery, check over these 5 points:

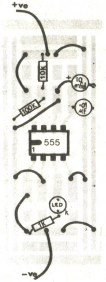
1. Does the dot on the end of the IC align with pin 1 on the board?
2. Does the long lead of the LED connect to pin 3?
3. Does the positive of the 10mfd electrolytic connect to pins 6 and 2?
4. Are the 7 jumper wires in position?
5. Are all the 8 pins of the IC connected?

Connect the battery. With a little bit of luck the LED will flash at 2Hz! If it doesn't, don't despair. Read the project through again. Look for these 6 possible faults:

1. Battery connected around the wrong way.
2. Solder bridging the copper tracks near the IC.
3. Parts touching.
4. LED inserted the wrong way around.
5. A missing jumper wire or part.
6. Weak battery.



Circuit 1 FLASHING LED



FLASHING LED LAYOUT

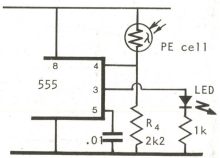
PROJECT TWO

LIGHT ACTIVATED FLASHING LED

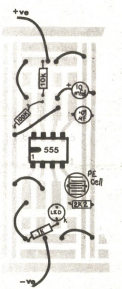
With the addition of only two components we can create three different effects on the flashing LED in the first circuit. A Light Dependent Resistor (LDR), more commonly known as a photocell can be combined with a resistor and connected into the circuit so that the LED flashes only when the room is illuminated or conversely, only when the room is in darkness. Another effect is achieved by wiring the LDR between pins 6 and 7. This will alter the flash frequency according to the amount of light falling on the LDR.

FLASHING LED WITH PHOTOCELL

Circuit 2 shows the photocell connected to pin 4. A 2.2k resistor is used to bias pin 4 at ground potential. When no light falls on the photocell pin 4 is effectively grounded. As the light intensity is increased the resistance of the photocell is reduced thus increasing the voltage on pin 4. A voltage level of about .8v is reached which is detected by pin 4 to turn on the oscillator. The sensitivity of the photocell can be adjusted by varying R4. By experimenting and finding a suitable value for R4, the LED may be made to turn on at the first sign of light.



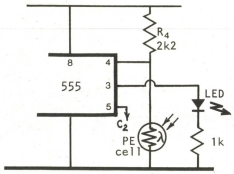
Circuit 2 HIGH ILLUMINATION WILL TURN LED OFF



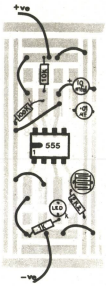
PROJECT THREE

If you want to reverse the effect – namely to extinguish the LED when the light is reduced, circuit 3 will create this effect.

It merely reverses the photocell and biasing resistor. As the light falling on the LDR increases, its resistance decreases and bring the voltage at pin 4 down to a point where the 555 timer will turn off.



Circuit 3 HIGH ILLUMINATION WILL TURN LED ON



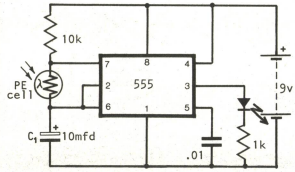
WHAT IS A PHOTOCELL?

A Photocell is a thin sheet of semiconductor material such as selenium, germanium or silicon which is sensitive to light. It has

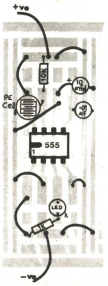
a parallel grid of 2 conducting wires etched over its face to increase the effective area of conduction. These two wires connect to 2 leads. The whole assembly is mounted behind a clear glass window so that light falling on the cell will change its resistance. Under very bright light its resistance will be in the order of only a few hundred ohms. This increase to over 1 meg in total darkness. This large change in resistance can be used to trigger the IC at specific illuminations or modulate the timing circuit to alter the rate of flashing.

PROJECT FOUR

To vary the frequency of flash we need only to replace R_2 with the photocell. As the light intensity on the photocell changes the charge time for C_1 will vary so that the LED will flash from one cycle every few minutes to a rate so high that it will be beyond your speed of counting. It will appear as if the LED is constantly glowing.



Circuit 4 LIGHT FALLING ON LDR WILL ALTER FLASH RATE



PARTS LIST

For circuits 1 - 5

Resistors:

1 - 1k
1 - 2k2
1 - 10k
1 - 100k

Capacitors:

1 - .01mfd ceramic
1 - .1mfd ceramic
1 - 10mfd electro

IC's:

1 - 555 IC (or NE 555)
(or SE 555)
(or LM 555)
1 - CD 4017 IC

1 - PE cell ORP 12
2 - Red LED's
1 - Push-on Switch
1 - 9v battery
1 - Battery clip

1 - 3-IC EXPERIMENTER BOARD

PROJECT FIVE

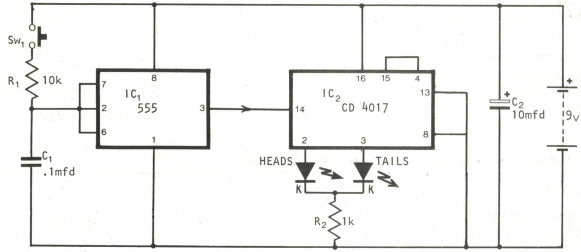
Heads or Tails?

A very simple circuit using a 555 timer and a counting IC.

Have you seen the electronic descision makers on the market? A number of models have been released. Most retail for around $15 to $30 and come in a variety of styles displaying either "HEADS/TAILS" or "YES" and "NO" or "DO IT NOW/DO IT TOMORROW". Effectively they are all the same – consisting of 2 red LEDS on a colourful background displaying the appropriate messages. They make a wonderful gift for a procrastinator or as a party game. A push button starts the LEDs flashing and they gradually slow down to a stable state of either yes or no.

The circuit for the HEADS or TAILS project uses IC's and 2 LEDs. The first IC is a 555 timer. The time-constant componerits comprising the 10k resistor R_1 and .1mfd capacitor C_1 have been chosen to enable the timer to oscillate at a frequency of 1500 Hz. The output at pin 3 feeds directly into the second IC, a CD 4017 decade counter. It is capable of counting up to ten then setting automatically to begin again. The IC can be programmed or to put it another way, can be adjusted to count up to 2,3,4,5,6,7,8 or 9 simply by connecting the next output to the reset pin. For instance: If you wish to count to 7, connect output 8 to the reset pin and the IC will count to 7 then reset again.

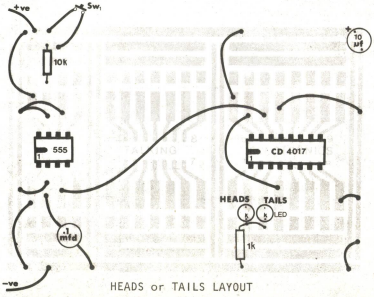
In this project we use only the first two outputs: pin 3 is the first output and pin 2 is the second output. The outputs do not correspond to the IC pin numbers but happen to fall in this order: 3-2-4-10-1-5-6-9-11. If we connect the third output (pin 4) to the reset pin 15, the IC will clock from 3 to 2 then reset back to 3 again. In other words it will oscillate between 3 and 2 at 750Hz at each output. Actually we are using a very complex IC for this simple project however, we will be utilizing more of the IC in the next project so don't worry about the cost at this stage.



Circuit 5. HEADS or TAILS.

Basically, this project performs the same task. Except that it doesn't have the sophistication of allowing the LEDs to slow down before locking into one stable state.

However, this breadboard project could be fitted into a small box and with a little imagination a colourful front panel could be designed to brighten it up and save yourself a lot of money over the bought model. Two very simple panels are included here to give you ideas to work from.



HEADS or TAILS LAYOUT

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LED ZEPPELIN

PARTS LIST:

1 - 270R ¼w
1 - 330R "
1 - 390R "
3 - 470R "
1 - 560R "
3 - 1k "
2 - 2k2 "
1 - 3k3 "
1 - 4k7 "
1 - 10k "
1 - 22k "
1 - 56k "
1 - 470k "

1 - 4.7mfd 16v
1 - 470mfd 16v

7 - BC 547
1 - BC 557

1 - CD 4001 IC

6 - Large red LEDs
1 - Mini red LED

2 - 1N 4148
1 - Push-on switch
1 - battery clip

Name: _____

Address: _____

_____

Enclose $5 plus $1 P&P.

Order forms:

Cut out the order forms and send them with sufficient money to cover post and pack to your choice of retailer listed on page 20. Any excess will be refunded.

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LIGHT THE LED

PARTS LIST:

1 - 22k ¼w
2 - 2k2 "
1 - 1k "

1 - 2.2mfd 10v
1 - 4.7mfd 10v

6 - 1N 4148

1 - Red LED

1 - CD 4017 IC

1 - Battery clip

Enclose $3 plus 50¢ P&P.

EXPERIMENTER BOARD

PARTS LIST:
For circuits 1-5

1 - 1k ¼w
1 - 2k2 "
1 - 10k "
1 - 100k "

1 - .01mfd ceramic
1 - .1mfd ceramic
1 - 10mfd electro 10v

1 - 555 IC
1 - CD 4017 IC

1 - PE cell ORP12 or similar
2 - Red LEDs
1 - Push-on switch
1 - battery clip

Enclose $5.30 plus $1 P&P.

Name: _____

Address: _____

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TALKING ELECTRONICS
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EXPERIMENTER DECK

Projects 1-10

1 - CD 4001 IC
1 - CD 4017 IC

1 - 15R ¼w
1 - 22R "
1 - 120R "
1 - 3k3 "
2 - 4k7 "
5 - 10k "
1 - 47k "
1 -100k "

1 - 1n 100v
1 - 3n3 "
1 - 3n9 "
3 - 6n8 "
2 -22n "
1 - 4.7mfd 10v
1 - 22mfd 10v

6 - 1N 4148

1 - 100k cermet pot VTP
1 - 500k " " "

1 - BC 557
3 - BC 547

1 - 2½" spkr 8ohm

30cm of 10-core ribbon

30cm tinned copper wire

Enclose $8.50 plus $1 P&P.

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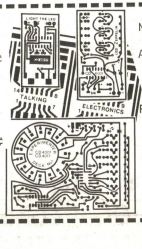
PC BOARDS: (✓)

( )	Light the LED	95¢
( )	LED Zeppelin undrilled	1.50
( )	" " drilled	1.80
( )	Experimenter Board 3-ICs	1.85
( )	Exptmr Deck undrilled	3.40
( )	" " drilled	3.75
( )	No 60 drill	85¢
( )	PC kit to make your own boards	7.00
	P&P	2.00
( )	Pkt of 20 transistors	2.40



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10-MINUTE DIGITAL COURSE

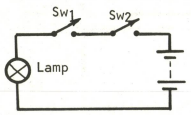
SIMPLIFIED FOR BEGINNERS

There are 5 basic logic elements: AND, OR, NOT, NAND, NOR.
This is how they operate:

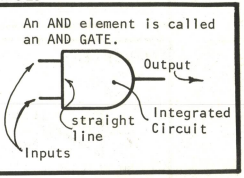
SYMBOLS

1

AND

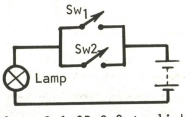


Close both Sw_1 and Sw_2 to light lamp.

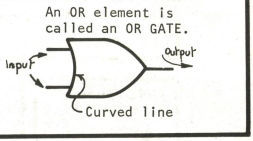


2

OR

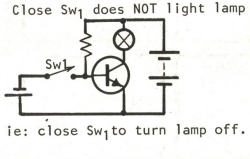


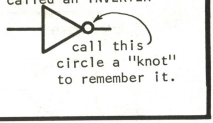
Close Sw1 OR Sw2 to light Lamp.



3

NOT

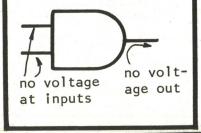


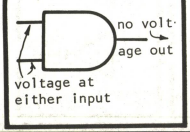


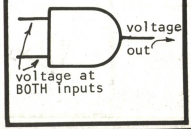
How AND, OR and NOT GATES work:

4

AND Gate:







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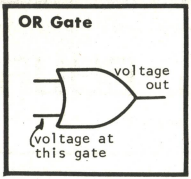

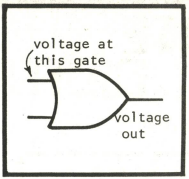

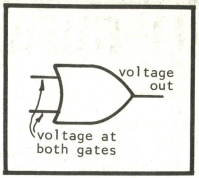

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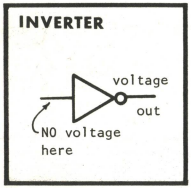
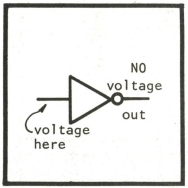




CALL THIS AN INVERTER

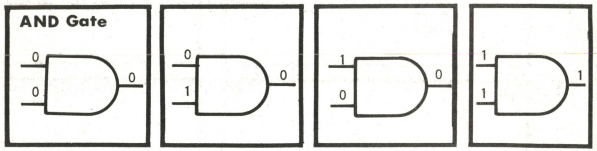
The 2 LOGIC NUMBERS:

0 = no voltage
1 = voltage

7

The Function of the 3 gates can be expressed in logic numbers

8



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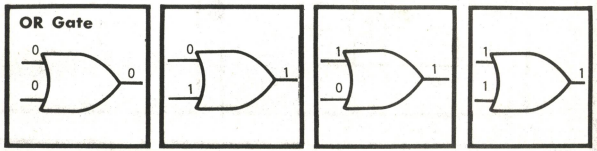
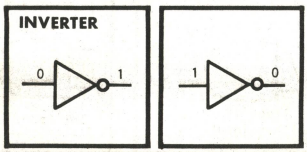


10



11

The numbers 0 and 1 are called logic values. Each gate can have 2 possible values. TRUE for logic level 1 and FALSE for logic level 0. Thus we can make a TRUTH TABLE for each of the gates.

AND Gate

INPUTS	OUTPUT
0 0	0
0 1	0
1 0	0
1 1	1

INPUTS	OUTPUT
*any combination	0
1 1	1

* means any combination except 1 1

OR

INPUTS	OUTPUT
0 0	0
0 1	1
1 0	1 1
1 1	1

INPUTS	OUTPUT
0 0	0
any other combination	1

NOT

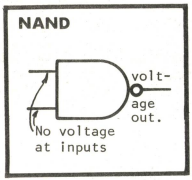
INPUT	OUTPUT
1	0
0	1

cannot be simplified except to say it's an inverter

Two further gates are:
NAND– the complement of a normal AND gate
NOR – the complement of a normal OR gate

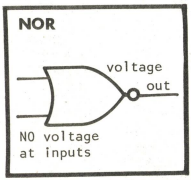
12

NAND



13

NOR



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A Career...

If you have a flair for electronics and like to experiment with new ideas, you may like to submit an item for publication. Any idea along the lines of the articles in this magazine will be welcome - extending to club news and even puzzles and games with an electronic flavour will be ideal. Payment ranges from $10 - $35 for a page item while a complete project will see $100 - $150 depending on the content and work required to arrange it for publication. So go to it. A small contribution may be your starting point to a whole new venture. In fact we are looking for two or three writers cum hobbyists to help us with the magazine either full or part-time at our office. This is the first time a national electronics magazine has eminated from Victoria and gives many aspiring enthusiasts an opportunity to work for a newly created publication.

There can't all be wrong:-

The Army, Police, Telecom, Schools, CSIRO, Govt. depts. Manufacturers (even Tandy & D.S. Dealers) plus 1000's of good old hobbyists. They all bought from us (or our W'sale dept.) because they like our quality, low prices and SAME DAY SERVICE. We are here to serve you — Take advantage of: Some of **AUSTRALIA'S LOWEST COMPONENT PRICES**

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.0022 - 5c	.022 — 6c	.22 — 15c
.0027 - 5c	.027 — 6c	.27 — 16c
.0033 - 5c	.033 — 7c	.33 — 18c
.0039 - 5c	.039 — 7c	.39 — 19c
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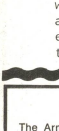

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4A	30V C106Y1	— 40
4A	400V C106D1	— 75
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Chart to identify leads
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50V	1N4001 - 5c
100V	1N4002 - 6c
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1000V	1N4007 - 11c

10% off 100 SAME

	ea.	10	100	1000
¼W 1%	2c	13c	90c	$8
½W	2c	18c	$1.40	$10¾

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2.2 ohm to 4M7 good quality.
Over stocked on less preferred E12-E6
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premixed in 100 lots same price as
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Same ohms
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Quality Large LEDS well difused wide viewing angle.

	each	10	100	1000
Red	15c	$1.40	$12	$110
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red **LEDS** **$12** a 100 **15c each** Best value
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Cap.	16V	25V	50V
0.47uF	4c($3½)	5c($3¾)	6c($4)
1, 2.2, 3.3, 4.7, 10uF	5c($3½)	6c($3¾)	7c($4)
22uF	6c($3¾)	7c($4)	
33uF	8c($4)		
47uF	9c($5)	10c($6)	11c($7)
100uF	10c($6)	12c($7)	14c($11)
220uF	12c($8)	16c($10)	35c($17)
470uF	16c($12)	22c($16)	45c($30)
1000uF	22c($18)	30c($25)	75c($50)

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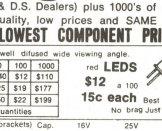
Signal Diode IN4148 **4c ea.** 35c per 10 **$3¼** a 100. $25/K



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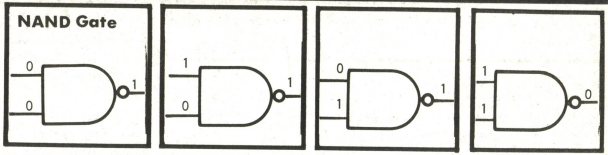
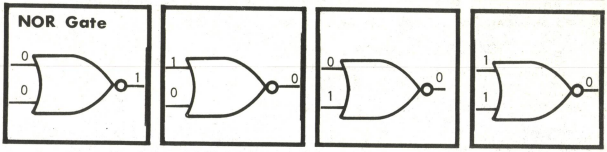
14 **NAND Gate**



15 **NOR Gate**



16

NAND Gate

INPUTS		OUTPUT
0	0	1
0	1	1
1	0	1
1	1	0

INPUTS	OUTPUT
1 1	0
any other combination	1

NOR Gate

INPUTS		OUTPUT
0	0	1
0	1	0
1	0	0
1	1	0

INPUTS	OUTPUT
0 0	1
any other combination	0

SUMMARY

For an AND gate:
A voltage at one input will have no effect but a voltage at both inputs will change the state of the output.

For an OR gate:
A voltage at one input will change the output and the other input will have no effect.

For an INVERTER
The output is of opposite logic level to the input.

For A NAND gate:
A voltage on one input will have no effect but a voltage at both inputs will change the state of the output.

For a NOR gate:
A voltage at either input will change the output.

TEST

Answer these questions:

1. Name the 4 commonly used types of gates:
2. What is the common name for a NOT gate?
3. What are the two TRUTH values?
4. Look at the four TRUTH tables to answer these:
   - A: With one gate of an AND GATE at logic 1 will the other gate alter the output?
   - B: With one gate of an OR GATE at logic 1 will the other gate alter the output?
   - C: With one gate or a NAND GATE at logic level 1 will the other gate alter the output?
   - D: With one gate of a NOR GATE at logic level 1 will the other gate alter the output?

TEST YOURSELF... No1

How good are you at identifying resistors? This quick test will give you a rating.

The most common component in electronics is the resistor. You see it so often you may take it for granted that you know a lot about resistors. But do you? Actually you could spend a whole lifetime studying resistor characteristics and insulating materials and still only know a fraction. This simple test should bring out your knowledge of resistors.

Can you name any other component which is made to exacting standards yet sells for just 2 cents? No, possibly not. Automation has made this possible as quarter and half watt resistors have reduced in price dramatically in the past decade and yet their quality has risen dramatically.

This test is graded into two sections: Beginners should attempt questions 1 to 10 while more advanced hobbyists can work right through. **The answers appear at the end of the test.**

1. Write down all the resistors between 10ohms and 270ohms: (use the E12 series or common series) (16 marks)

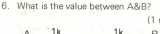
2. Draw the symbol for:
   (a) A fixed resistor (1 mark)
   (b) A potentiometer (1 mark)

3. What is the difference in appearance between a 47ohm resistor and a 4k7 resistor? (1 mark)

4. Write down the value of these resistors:
   (a) red–red–orange: (4 marks)
   (b) yellow–purple–brown: (4 marks)
   (c) blue–grey–orange: (4 marks)
   (d) red–purple–green: (4 marks)
   (e) green–blue–red: (4 marks)

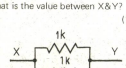
5. What are the colours of these resistors?
   (a) 2.2M (4 marks)
   (b) 470ohm (4 marks)
   (c) 56k (4 marks)
   (d) 220ohm (4 marks)
   (e) 3k3 (4 marks)

6. What is the value between A&B? (1 mark)



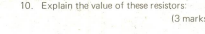
7. If two resistors have the same colours but are of different size; what does this tell us? (1 mark)

8. What is the value between X&Y? (1 mark)



9. What is the value of these resistors?
   (a) Silver–green–orange–orange: (4 marks)
   (b) Gold–brown–purple–red: (4 marks)

10. Explain the value of these resistors: (3 marks)



Total 73 Marks

SECTION 2: More Advanced

11. With 2 resistors in series, why should the value of each be nearly the same: (4 marks)

12. Choose ½ watt resistors to make each of these values:
    (a) 1k 1 watt: (2 marks)
    (b) 3k3 2 watt: (2 marks)
    (c) 4M7 1 watt: (2 marks)

13. Give 2 situations where question 12 may arise in practice:
    (i)
    (ii) (2 marks)

14. Explain why this is unnecessary (Hint: tolerance) (1 mark)

15. A 2k2 ½ watt resistor is getting too hot. What should you do? (1 mark)

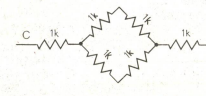
16. Four resistors, all consisting entirely of red bands, are paralleled. What is the combined resistance? (4 marks)

17. How can you detect, without instruments, if a wire-wound resistor is not functioning? (1 mark)

18. What is the value of these?
    (a) yellow–purple–gold–silver: (4 marks)
    (b) red–red–gold–gold: (4 marks)
    (c) yellow–purple–silver–gold: (4 marks)

19. What are the colours of these resistors?
    (a) R27 10% (4 marks)
    (b) 1R5 10% (4 marks)
    (c) 3R3 5% (4 marks)
    (d) 1R0 5% (4 marks)

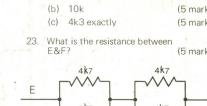
20. What is the value across the terminals C&D? (5 marks)



21. From a sample of 50 different resistors, which colour appears most often? (2 marks)

22. A black bag contains 10 1k resistors and 10 3k3 resistors. How many resistors must you choose to be guaranteed a resistance of:
    (a) 1k (5 marks)
    (b) 10k (5 marks)
    (c) 4k3 exactly (5 marks)

23. What is the resistance between E&F? (5 marks)



Total 74 Marks

Answers:

1. 12ohms, 15ohms, 18ohms, 22ohms, 27ohms, 33ohms, 39ohms, 47ohms, 56ohms, 68ohms, 82ohms, 100ohms, 120ohms, 150ohms, 180ohms, 220ohms. 2. (a) (b) 3. The third colour band: black, red. 4. (a) 22k (b) 470ohms (c) 68k (d) 2M7 (e) 5k6 5. (a) red–red–green (b) yellow–purple–brown (c) green–blue–orange (d) red–red–brown (e) orange–orange–red 6. 2k 7. Their wattage is different 8. 500ohms 9. They were read around the wrong way! (a) 3M3 10% (b) 270ohms 5% 10. 22ohms; 3point3 ohms; point 22 ohms 11. So the heat dissipated by each will be nearly the same. So that the voltage across each will be nearly the same. 12. (a) Two 2k2 resistors in parallel or two 470ohm resistors in series (b) Four 12k resistors in parallel or four 820ohm resistors in series (c) A 2M2 and 2M7 resistor in series or two 10M resistors in parallel. 13. When no 1 watt resistor is available, when a high voltage is present two resistors are put in series. 14. The tolerance of the 4M7 resistor will swamp the small effect of the 1k resistor. 15. Check the circuit for leaky or shorted transistors. If the voltage across the resistor is correct it may need a higher wattage. 16. 550ohms 17. Touch it with a wet finger, it should be hot. 18. (a) 4R7 10% (b) 2R2 5% (c) R47 5% 19. red–purple–silver–silver (b) brown–green–gold–silver (c) orange–orange–gold–gold (d) brown–black–gold–gold 20. 3k 21. red 22. This is a trick question. (a) you must choose 3 resistors which can be paralleled up to give 1k1 or 1k. (b) 12 resistors, at worst you may be choosing nine 1k resistors then you need three at 3k3. (c) 11 resistors. 23. 4k7.

SCORE:

For each section:

Over 65 marks	— Excellent
Over 50	— Very Good
Over 40	— Good
Below 40	— Not a Pass

THE TRANSISTOR PAGE

A SERIES OF PROJECTS USING PARTS FROM YOUR JUNK-BOX.

NO — WE HAVEN'T FORGOTTEN THE TRANSISTOR!

Here are 5 novel circuits you can build with any small-signal silicon transistors. You may use any odd transistors you have in the junk-box or take advantage of the special offer of 20 transistors for $2.40 Any transistors salvaged from computer boards or having an odd type number can be identified as either PNP or NPN by testing it with the SIMPLE TRANSISTOR TESTER described in this article. It does not give any other characteristics however,as these circuits are so simple that you can use any of them as a tester in themselves. The TICKING BOMB, for instance, is ideal as it uses both an NPN and a PNP transistor so that either one can be substituted with an unknown type. As a precaution against reverse voltage you should include a 1k resistor in series with one lead of the battery. This will limit the reverse current to 10ma while the electrolytic reduces the impedance of the supply to enable the circuit to operate.

The transistor offer contains 20 NEW and fully guaranteed transistors. They are not rejects or seconds. This offer has been made available by this magazine at almost cost-price to encourage new experimenters into the field of MAKING rather than looking and thinking. Some electronics shops are also participating in this offer so ask the manager of your local shop first, before sending for the offer.

The whole 5 circuits can be constructed on one piece of veroboard strip, 81 holes long by 15 holes wide. The cost of this is less than $2. The board can be cut into lengths for each project to make a neat and thoroughly presentable finish. The 81 copper strips run across the board and have been cut in the middle by the manufacturer, making over 160 useful contact pads.

transistor offer:

Please send 1 pack of 20 transistors @ $2.40 plus 60¢ post to:

NAME_ _ _ _ _ _ _ _ _ _ _ _ _ _ _ _ _

ADDRESS_ _ _ _ _ _ _ _ _ _ _ _ _ _ _ _ _

_ _ _ _ _ _ _ _ _ _ P/code_ _ _ _ _

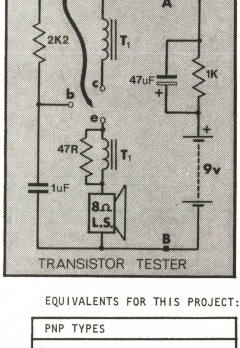
I enclose cheque/postal order for $3.00

Send to: TALKING ELECTRONICS MAGAZINE
35 Rosewarne Ave.,
Cheltenham, 3192.

Coupon not essential in some states of Aust. for this offer.

A SIMPLE TRANSISTOR TESTER

Do you have a number of transistors which have their numbers rubbed off or odd transistors of an un-identified type?
This circuit will test them and find out if they are PNP or NPN. It is short-circuit proof so putting a transistor round the wrong way will not damage it. The diagram is set for NPN types. The terminals marked C B and E can be alligator clips on short lengths of hook-up wire. The transformer T_1 is a speaker transformer salvaged from a transistor radio. It can have any impedance such as 400:8 ohm and must be inserted so that the primary winding gives a feed-back to the secondary winding. When this occurs, you will hear a whistle in the speaker. Now you are ready to try all your odd types. Those that do not oscillate should be put aside and re-tested when the battery with its current limiter is reversed at terminals A and B.



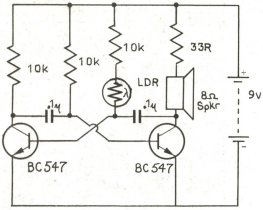
EQUIVALENTS FOR THIS PROJECT:

PNP TYPES		
BC 157	BC 158	BC 159
BC 177	BC 327	BC 557
BC 558		
NPN TYPES		
BC 107	BC 108	BC 207
BC 208	BC 337	BC 547
BC 548	BC 635	

...the transistor page

LIGHT ALARM

This project has a number of uses. Essentially it is a light alarm which is triggered into oscillation by the Light-Dependent-Resistor. Under dark conditions the LDR has very high resistance and thus the first transistor has no bias on its base. This prevents the multi-vibrator from functioning and in this condition draws only about 1ma. As the light intensity increases, the resistance of the photocell decreases and the multi-vibrator starts up. Its frequency gradually rises to a high pitched whistle as set by the limiting resistor in series with it. Now, the possibilities for an alarm of this nature are endless. It will give an audible indication of the intensity of a light source or compare two illuminations. As an alarm it is useful as a theft device. It can be put into a cupboard or drawer to protect it from prying fingers. It can be used as an alert for the medicine chest or money drawer. In any case its advantage lies in the fact that it doesn't have to be wired to any switches and can be moved around with ease.



LIGHT ALARM

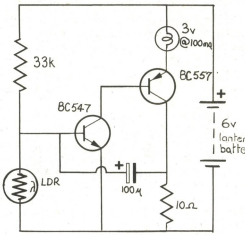
A piece of veroboard 12 holes long will accommodate all the parts making it a very compact project which can be disguised as a packet of pills by using a suitable empty container.

Parts

2 transistors BC 547
3 resistors 10k
1 resistor 33 ohm
2 capacitors .1mfd
1 LDR type ORP12
1 2½" speaker 8 ohm
1 9volt battery
1 battery clip
1 piece of veroboard

BLINKER

Have you seen the blinking lights at the road-side to warn motorists of roadworks or an excavation? These lights turn off during the day and begin to operate only at dusk. They contain 1 or 2 lantern batteries, a Light-Dependent-Resistor and a 2-transistor flasher. The main requirement for a circuit to operate this type of warning device (apart from creating the flashes) is for its daytime current to be as low as possible to conserve battery. Since the flash of the globe is extremely short, the average current drawn from the battery will be quite small. This circuit achieves both of these requirements.



"BLINKER"

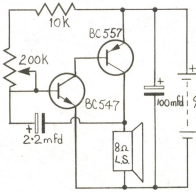
The stand-by current is only 100microamp and the average operating current is less than 25 milli-amps. The only two critical components in the circuit are the 10 ohm resistor and globe. The resistor must be 10 ohms. A 5 ohm or 15 ohm resistor will not work. The lamp must be a low current type. A miniature model railway globe of about 3v - 4v is ideal. It must be rated at .05 to .1 amp to operate successfully. Ordinary torch globes of 2.5v @ 300ma will not work at all. Use a light dependent resistor type ORP12 or similar which has a dark resistance of 10M and a light resistance of 300 ohms.

Parts

1 transistor BC 547
1 transistor BC 557
1 resistor 33k
1 resistor 10 ohm
1 LDR type ORP12
1 electro 100mfd 16v
1 globe 3v 100ma
1 6v lantern battery
1 piece of veroboard

TICKING BOMB

When you build this circuit you will see what we mean. The effect from the speaker is very similar to a loud ticking clock. The 100mfd electrolytic is very important. It reduces the internal impedance of the battery (especially if it is low) and changes the tone from a soft tick to a very loud sharp click. It also reduces the current from 25ma to about 2ma. The circuit operation is very simple. On connecting the battery the 10k resistor, 200k pot, 2.2mfd capacitor and 8 ohm speaker are the only parts drawing current. As the capacitor begins to charge the base voltage on the NPN transistor rises to about .6v This turns the transistor on and in turn switches the second transistor to a conducting state. This results in a click from the speaker. At the same time the negative lead of the electrolytic is brought nearer the positive rail and thus the charge on the electrolytic is reduced. This turns off the first and second transistors to begin the cycle over again.



"TICKING BOMB"

The rate of charge of the electrolytic is dependent upon the value of the resistors in series with it. Thus the rate of ticking can be altered by the trim pot. Almost any NPN and PNP transistors can be used in this circuit. In fact this circuit is an ideal simple test for transistors. It will determine if they are NPN or PNP. All the parts are mounted on a small piece of veroboard 15 holes by 15 holes.

Parts

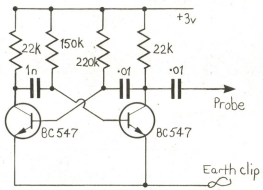
1 transistor BC 547
1 transistor BC 557
1 resistor 10k
1 electro 2.2mfd 16v
1 mini-trim pot 200k
1 electro 100mfd 16v
1 2½" speaker 8 ohm
1 9v battery
1 battery clip
1 piece of veroboard

SIGNAL INJECTOR

This circuits produces a very handy signal injector. It is a free-running multivibrator with an output of square wave form at a fundamental frequency of about 2kHz and thus is rich in harmonics and can provide a continuous note when injected into any receiver, up to about 20MHz.

The signal injector can be fitted into a plastic tube about 10 to 15 cm long so before cutting the veroboard it is best to find a container. A small plastic pill bottle is ideal and the veroboard can be cut to size. The probe can merely be a long thin bolt mounted in the centre of the lid.

To find a fault in an amplifier or superhet radio, simply connect the earth lead to the chassis of the amp and move through each stage starting at the speaker. Obviously an increase in volume should be heard at each preceeding stage. This injector will also go through the IF stages of radios and FM sound sections in TV's. Use 2 mercury button batteries for the supply and fabricate a switch into the screw-on lid. The first use for this injector will be to test the operation of the next project...The MINI AMPLIFIER.



SIGNAL INJECTOR

Parts

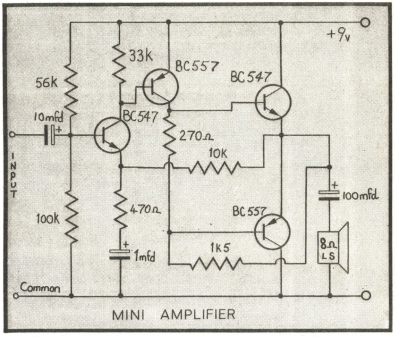
2 transistors BC 547
2 resistors 22k
1 resistor 150k
1 resistor 220k
1 capacitor 1000pf
2 capacitors 10n
1 earth clip
1 probe tip
2 button cells
1 plastic container
1 piece of veroboard

MINI AMPLIFIER

This 4-Transistor COMPLEMENTARY PUSH-PULL amplifier is designed around discrete components to show the basics of audio amplifier design. This type of circuit requires relatively few components, needs no transformers and provides very good results. The four transistors are directly coupled and DC feed-back loops help stabilize working conditions throughout. Transistors 3 and 4 are arranged as a complementary pair operating in push-pull. Each output transistor deals with one half of the audio cycle, one being cut-off when the other is driven into conduction. This is economical on battery current, which is quite low with moderate volume, rising to 25 - 30ma as volume is increased. This gives us a 250 milliwatt amplifier, enough to drive a loudspeaker to the same volume as a transistor radio.

The first two transistos operate as a pre-amp to increase the incomming voltage to drive the output pair. The bias of the whole circuit commences with the voltage divider made up of the 56k and 100k resistors. This provides the base with a bias voltage of 5.5v The emitter voltage will be .6v less than this, and will be 4.9v The second transistor is biased so that it provides a voltage across the 270 ohm load resistor which will give the output transistors a voltage differential of .6v between their base and emitter leads.

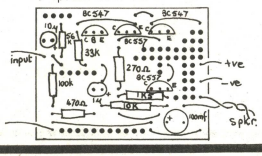
This is needed to reduce cross-over distortion which occurs whenever two transistors are connected in push-pull. The 100mfd electrolytic prevents DC from appearing across the speaker which would "off set" the cone. The DC would pull the cone in a little and require the speaker to oscillate around this new position.



MINI AMPLIFIER

Parts

2	transistors	BC 547
2	transistors	BC 557
1	resistor	270 ohm
1	"	470 ohm
1	"	1k5
1	"	10k
1	"	33k
1	"	56k
1	"	100k
1	electro	1mfd 16v
1	"	10mfd 16v
1	"	100mfd 16v
1	2½" speaker	8 ohm
1	9v battery	
1	battery clip	
1	piece of veroboard	



The amplifier may be driven from a ceramic cartridge in a record player or across the volume controlof a transistor radio. The input must be about 100 - 500 millivolts to drive the amplifier fully. A small piece of veroboard 20 - 25 holes long is needed for the amplifier. Make a layout diagram first which very nearly follows the schematic diagram before attempting any soldering. With care you will find you will not have to cut any of the veroboard tracks and most of the parts will fit neatly onto the board as they all .1" spacing. When you have completed soldering, connect the battery via a milli-ammeter to check that the current is within 30ma and most probably be 5 - 15 ma with no input signal applied. You may like to trace through the amplifier with the signal tracer from the previous project and satisfy yourself where the amplification is performed and where voltage comparisons are maintained. Obviously all the stages cannot provide amplification since a transistor can achieve a gain of at least 20 times and sometimes an in-circuit gain of 100. Thus this amplifier would achieve at least 20 x 20 x 20 or 8,000 times! But this is not so. With the input requirement of about 250 milli-volts the amplifier needs to provide a gain of about 40 to 80 times. Your signal tracer will indicate which transistor is providing this gain. See for yourself.

In all, these combined 5 transistor projects should give you hours of fun.

EXPERIMENTER DECK

BUILD THESE 10 EXPERIMENTS ON ONE PC BOARD:

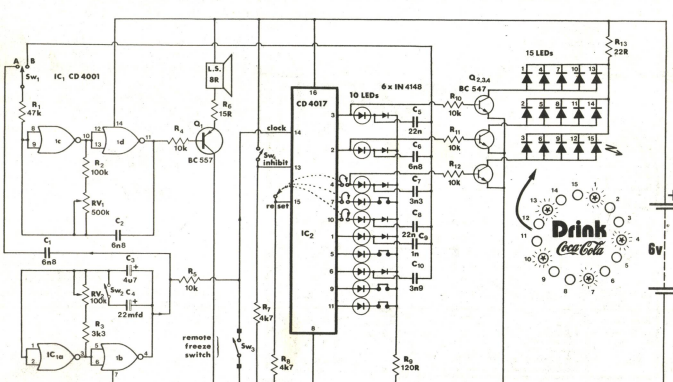
1. HEE HAW SIREN
2. HEADS or TAILS?
3. DECISION MAKER
4. RUNNING LIGHT
5. CRICKET GAME
6. TIMER
7. TEST YOU REFLEX TIME
8. TUNE
9. MAKING MUSIC
10. ADVERTISING SIGN

'THE DECK'.... What does it do?

These 10 projects are presented in a graduated form. The first project "HEE HAW SIREN" uses only 25% of the parts --- each preceeding project uses either additional parts or a different combination of switches or potentiometer settings to give a completely different experiment. This gives the EXPERIMENTER DECK a wide variety of uses and an allowance has been made for additional experimenting such as in project number 8, in which the pre-programmed tune can be re-programmed to any tune or scale you wish.

The circuit board builds up to the final project THE ADVERTISING SIGN which uses all the parts including the circle of 15 LEDs to flash in a similar manner to lights running round a neon sign or movie screen at a drive-in. The combination of the duel frequency tone from the speaker, 3 LEDs from the train of LEDs acting in a pump-like manner and the 15 circulating LEDs, is really captivating in a darkened room. It's like a miniature sound-and-light display.

Only the first project: HEE HAW SIREN, is presented in this issue. We advise, however, to purchase the full kit of parts in readiness for the next issue. Keep them in a safe place. The complete circuit may look complex but each individual project is simple.



COMPLETE "10 EXPERIMENT" CIRCUIT

Complete list of parts for the 10 projects:

1 - EXPERIMENTER DECK No1 PC board

1 - CD 4001 IC
1 - CD 4017 IC

R1	Resistor	47k	¼watt
R2	"	100k	"
R3	"	3k3	"
R4	"	10k	"
R5	"	10k	"
R6	"	15R	"
R7	"	4k7	"
R8	"	4k7	"
R9	"	120R	"
R10	"	10k	"
R11	"	10k	"
R12	"	10k	"
R13	"	22R	"

C1	Capacitor	6n8	100v	(6800pf,.0068)
C2	"	6n8	"	(" ")
C3	Electrolytic	4u7	10 - 35v	(4.7mfd)
C4	"	22mfd	10 - 16v	
C5	Capacitor	22n	100v	(.022mfd)
C6	"	6n8	"	(6800pf,.0068)
C7	"	3n3	"	(3300pf,.0033)
C8	"	22n	"	(.022mfd)
C9	"	1n	"	(1000pf,.001)
C10	"	3n9	"	(3900pf,.0039)

6 - Diodes IN 4148 or IN 914

RV1 - Mini trim pot 500k Cermet type VTP
RV2 - Mini trim pot 100k Cermet type VTP

25 - LEDs or 24 red LEDs & 1 green LED.

Q1 - Transistor BC 557 or any PNP type
Q2 - " BC 547 or any NPN type
Q3 - " "
Q4 - " "

1 - Speaker 2½", either 3Ω,8Ω,15Ω or 33Ω.

30cm of 10 core ribbon cable or 10 pieces of coloured hook-up flex

1 - Length of tinned copper wire or pieces cut from resistors

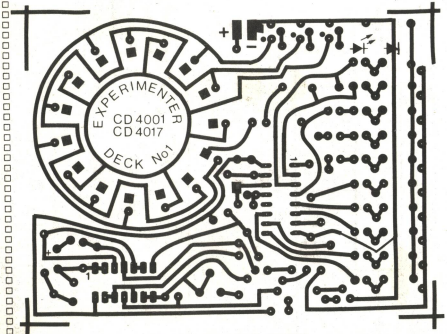
1 - 6v lantern battery

Roll of fine solder (as thin as resistor leads)

Soldering iron - preferably a constant-heat type or a small mains-voltage iron. But NOT an instant heat iron as it will lift the copper circuit off the board.

Side-cutters

This is a full-size artwork for the EXPERIMENTER DECK PC board. You can make your own board if you follow the instructions in the previous project "MAKE YOUR OWN PC BOARDS". Or you can buy it ready drilled or just etched and drill it yourself with a number 60 drill. Which ever way you choose, be sure to initiate yourself now. Time goes so fast. The next issue will be around and you haven't started. Don't forget: When soldering the parts, follow through the experiments in a logical order. This will not only make construction easy but produce 10 different projects, all for about $16.



PC BOARD

Cut out the sign and paste it onto the PC board inside the ring of 15 LEDs for the ADVERTISING SIGN PROJECT.

HEE HAW SIREN

PROJECT ONE

A Hee Haw siren reminds us of police, fire and ambulance. The idea of emitting two different notes is not new. Its effectiveness in alerting our attention is well known. Take, for instance, a simple two-tone door bell or the telephone bell. They are considerably more alerting than a constantly ringing bell because a continuous note tends to blend in with the background noise. However a constantly ringing bell on board ship is the most frightening of all as it signifies FIRE!

This project uses a single IC to give two tones. A transistor amplifies this to drive a speaker. The resulting HEE HAW can be adjusted via two mini trim pots to sound just like a fire truck or re-adjusted to sound like a computer gone wild.

Parts for this project:

1 - EXPERIMENTER DECK PC board
R1 Resistor 47k
R2 " 100k
R3 " 3k3
R4 " 10k
R6 " 15R

C1 Capacitor 6n8 100v
C2 " 6n8 "
C3 Electrolytic 4u7 10v
C4 " 22mfd 10v

RV1 Mini trim pot 500k Cermet
RV2 Mini trim pot 100k Cermet

Q1 Transistor BC 557 or similar

IC1 CD 4001

1 2¼" speaker

Hook-up flex

Tinned copper wire

6v lantern battery

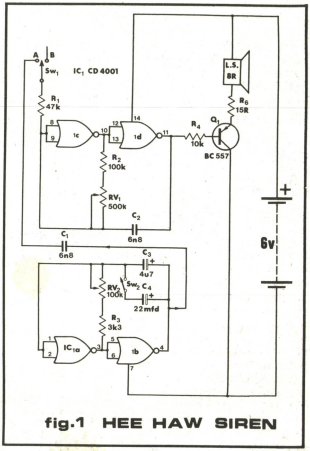
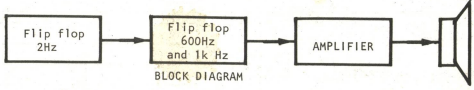


fig.1 HEE HAW SIREN

HOW THE CIRCUIT WORKS:

The circuit consists essentially of two multivibrators. A multivibrator can also be called a FLIP-FLOP. The word flip-flop sounds much better so we'll use it. These two flip-flops are arranged to oscillate at widely differing frequencies. The first oscillator has a frequency of 25Hz when the potentiometer RV2 is at minimum resistance so that the 3k3 resistor R_3 is providing the oscillator frequency. By adjusting RV_2 slightly we obtain the characteristic HEE HAW sound. This frequency is now about 2Hz. Altering the switch Sw_2 will give us a single note which will be sustained for up to 4 secs then change in pitch. The note we hear is actually the frequency of the second flip-flop being modified by the first flip-flop. This is achieved by the effect of the 6n8 capacitor on the input gates 8&9.



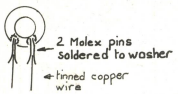
BLOCK DIAGRAM

The 2Hz flip-flop modulates the 2nd flip-flop to give a frequency of 600Hz or 1kHz.

PREPARING THE PRINTED CIRCUIT BOARD:

Before mounting any parts, the PC board requires 10 jumper wires. Refer to the layout diagram for the exact positions of these jumpers. They are made from tinned copper wire or from the leads of resistors. Be sure to locate the correct holes as you will be using them as a guide to positioning the parts in the future. You will notice some of these jumpers are required for the HEE HAW SIREN while others are used in later projects. But it is best to fit them all now.

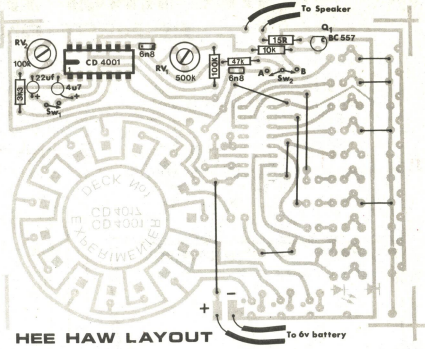
Make two switches as shown here:



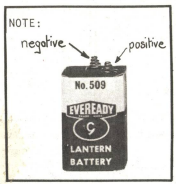
They will be needed for the first project. Any type of terminal pin will be suitable and even a full-size switch may be used, connected to 30cm of hook-up wire.

MOUNTING THE PARTS

Fit the two mini trim pots. Cermet trim pots are preferred as you can turn their body with your fingers or use a screwdriver in their slot. Start at the left-hand side of the PC board and fit each component in turn. The CD 4001 IC should be left until last as it is a CMOS IC and requires fast insertion to protect it from static build-up. Once it is soldered in position it is quite robust. Use your fingers to heat-sink the IC so that it does not get too hot. Connect hook-up wire to the places marked for the speaker and battery. No on-off switch is shown in the diagram as the wire can be fitted under the spring terminals of the battery or 2 alligator clips can be connected to the battery terminals.



HEE HAW LAYOUT



After soldering all the parts onto the PC board, check once more with the layout diagram, then connect the battery. By varying the two trim pots you will be able to get a wide variety of notes which will very from a HEE HAW SIREN for a toy fire engine to a type of electronic music emitted when a computer goes wrong.

Projects 2 - 10 will be presented in the next issue. Don't miss your copy!

Quiz: What have you learned?

1. How many pins does a CD 4001 have?
2. What type of IC is the CD 4017?
3. What type of gate is inside the CD 4001?
4. Which lead is the cathode? →|
5. Identify each pin by referring to the projects and circuit diagrams in this issue:

6. In about 50 words describe what new items you have learnt from this issue:

DATA

Sheet No.2.

CAPACITOR:

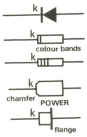
mfd = microfarad
pf = picofarad
n = nanofarad

1000pf = 1n
1n = .001 mfd
1000n = 1 mfd
2n2 = .0022 mfd
22n = .022 mfd
220n = .22 mfd

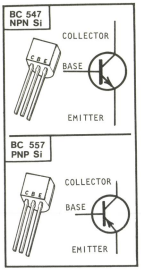
102 = 1,000pf
103 = 10,000pf
= .01 mfd
104 = .1 mfd
105 = 1 mfd

472 = .0047 = 4n7
473 = .047 = 47n
474 = .47 = 470n

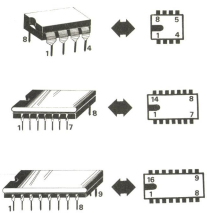
DIODE:



TRANSFORMER:



IC PIN NUMBERS:

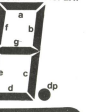


USING A MULTIMETER TO FIND PNP or NPN:

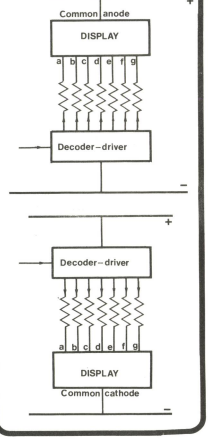
1. Clip meter -ve lead onto centre lead of transistor.
2. Set multimeter to high ohms (x1k range)
3. Positive lead to outer pins reads:
   HIGH-HIGH IT's PNP
   LOW-LOW IT's NPN

If "B" unknown - use transistor tester on Page 27 of issue No1.

7-SEGMENT DISPLAY

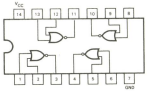


WIRING DISPLAYS:

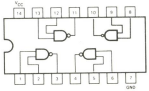


PIN OUTS:

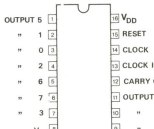
CD 4001



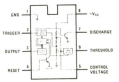
CD 4011



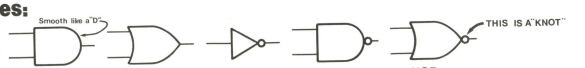
CD 4017



555



Gates:



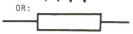
CPW

TALKING ELECTRONICS IS DESIGNED AND PUBLISHED AT 35 ROSEWARNE Ave, CHELTENHAM 3192 550 2386 584 2386 ©1981

DATA

RESISTOR:

OR:



Ω = ohms
R = ohms
k = 1,000 ohms
M = 1,000,000 ohms

POTENTIOMETER:

OR:

103 = 10k ohms
104 = 100k "
105 = 1M ohms

CAPACITOR:

mfd = microfarad
pf = picofarad
n = nanofarad

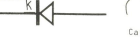
1000pf = 1n
1n = .001mfd
1000n = 1 mfd
2n2 = .0022 mfd
22n = .022 mfd

102 = 1,000pf
103 = 10,000pf
= .01 mfd
104 = .1 mfd
105 = 1 mfd

ELECTROLYTIC:

BATTERY:

DIODE:



SIGNAL DIODE:

POWER DIODE:

LED:

Cathode lead is SHORT

LOOKING INTO LED. Cathode is LARGER.

COLOUR CODE FOR RESISTORS

Silver or gold here is a divisor, NOT tolerance.

Silver: DIVIDE by 100
Gold: DIVIDE by 10

TOLERANCE:
Silver 10%
Gold 5%

Resistance:	Preferred Notation:									
.22ohm	R22	red	red	silver	silver	1.2k	1k2	brown	red	red
.27ohm	R27	red	purple	silver	silver	1.5k	1k5	brown	green	red
.33ohm	R33	orange	orange	silver	silver	1.8k	1k8	brown	grey	red
.39ohm	R39	orange	white	silver	silver	2.2k	2k2	red	red	red
.47ohm	R47	yellow	purple	silver	silver	2.7k	2k7	red	purple	red
.56ohm	R56	green	blue	silver	silver	3.3k	3k3	orange	orange	red
.68ohm	R68	blue	grey	silver	silver	3.9k	3k9	orange	white	red
.82ohm	R82	grey	red	silver	silver	4.7k	4k7	yellow	purple	red
1.0ohm	1R0	brown	black	gold	silver	5.6k	5k6	green	blue	red
1.2ohm	1R2	brown	red	gold	silver	6.8k	6k8	blue	grey	red
1.5ohm	1R5	brown	green	gold	silver	8.2k	8k2	grey	red	red
1.8ohm	1R8	brown	grey	gold	silver	10k	10k	brown	black	orange
2.2ohm	2R2	red	red	gold	silver	12k	12k	brown	red	orange
2.7ohm	2R7	red	purple	gold	silver	15k	15k	brown	green	orange
3.3ohm	3R3	orange	orange	gold	silver	18k	18k	brown	grey	orange
3.9ohm	3R9	orange	white	gold	silver	22k	22k	red	red	orange
4.7ohm	4R7	yellow	purple	gold	silver	27k	27k	red	purple	orange
5.6ohm	5R6	green	blue	gold	silver	33k	33k	orange	orange	orange
6.8ohm	6R8	blue	grey	gold	silver	39k	39k	orange	white	orange
8.2ohm	8R2	grey	red	gold	silver	47k	47k	yellow	purple	orange
10ohm	10R	brown	black	black	silver	56k	56k	green	blue	orange
12ohm	12R	brown	red	black	silver	68k	68k	blue	grey	orange
15ohm	15R	brown	green	black	silver	82k	82k	grey	red	orange
18ohm	18R	brown	grey	black	silver	100k	100k	brown	black	yellow
22ohm	22R	red	red	black	silver	120k	120k	brown	red	yellow
27ohm	27R	red	purple	black	silver	150k	150k	brown	green	yellow
33ohm	33R	orange	orange	black	silver	180k	180k	brown	grey	yellow
39ohm	39R	orange	white	black	silver	220k	200k	red	red	yellow
47ohm	47R	yellow	purple	black	silver	270k	270k	red	purple	yellow
56ohm	56R	green	blue	black	silver	330k	330k	orange	orange	yellow
68ohm	68R	blue	grey	black	gold	390k	390k	orange	white	yellow
82ohm	82R	grey	red	black	gold	470k	470k	yellow	purple	yellow
100ohm	100R	brown	black	brown	gold	560k	560k	green	blue	yellow
120ohm	120R	brown	red	brown	gold	680k	680k	blue	grey	yellow
150ohm	150R	brown	green	brown	gold	820k	820k	grey	red	yellow
180ohm	180R	brown	grey	brown	gold	1M	1M	brown	black	green
220ohm	220R	red	red	brown	gold	1.2M	1M2	brown	red	green
270ohm	270R	red	purple	brown	gold	1.5M	1M5	brown	green	green
330ohm	330R	orange	orange	brown	gold	1.8M	1M8	brown	grey	green
390ohm	390R	orange	white	brown	gold	2.2M	2M2	red	red	green
470ohm	470R	yellow	purple	brown	gold	2.7M	2M7	red	purple	green
560ohm	560R	green	blue	brown	gold	3.3M	3M3	orange	orange	green
680ohm	680R	blue	grey	brown	gold	3.9M	3M9	orange	white	green
820ohm	820R	grey	red	brown	gold	4.7M	4M7	yellow	purple	green
1k	1k	brown	black	red	gold	5.6M	5M6	green	blue	green

Any transistor CASE may be PNP or NPN.

CAPACITOR COLOUR CODE:

BLACK	0	0	x1pF x1uF		10v
BROWN	1	1	x10pF x10uF		
RED	2	2	x100pF	250v	
ORANGE	3	3	x1000pF		
YELLOW	4	4	x0.01mfd	400v	6.3v
GREEN	5	5	x0.1mfd	100v	16v
BLUE	6	6		630v	
VIOLET	7	7			
GREY	8	8	x0.01mfd		25v
WHITE	9	9	x0.1mfd		3v
PINK					35v

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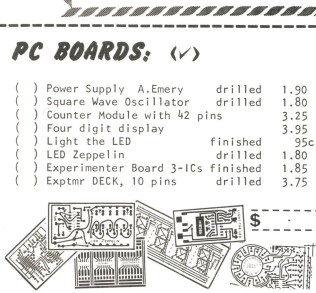

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FOR ISSUES 4-9

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TECHNICAL WRITING

Technical writing is an art. It requires the combining of three talents. Correct expression, an understanding of electronics, and an exciting presentation.

Just as you master electronic circuitry by experimentation, the written aspect must also be learnt. In each issue we will feature an article on technical writing. As with electronics, it will have to be actually physically attempted, to benefit you. This month we start with a short article on PREFERRED VALUES. It is reproduced here and attempts to explain a quite simple aspect of electronics. The origin and its author don't concern us. We don't want to be critical of the author but use his efforts as a basis to mastering better writing.

Firstly I suggest you read through the article. To me, it was quite confusing and left me no better informed. It falls down on three sides. Apart from the technical inaccuracies, it is mainly the phrasing of the sentences which I wish to restructure with you. The writing is hard to read, fails to convey the message and doesn't have any flow. We will go through the article paragraph by paragraph and improve the grammar. At the end of this article you will be required to write and improved version of "PREFERRED VALUES" in you own words.

Always commence with a short sentence. Short sentences are fast reading. They spur the reader on. A sentence should contain only ONE idea. The first sentence is too long. Break it into two, something like this:

Have you ever wondered why resistors have 22, 47 or 68 on them? They appear to be such odd numbers. Actually they have been very carefully chosen, and are part of a system called "PREFERRED VALUES".

Notice he has two 'whats' in the first paragraph. NEVER USE 'WHAT or THAT". In the second paragraph we must remove the word 'what'. The sentence becomes:

....components were given seemingly normal values of 10, 20, 30 and so on.

The remaining part of the paragraph is extremely difficult to follow as there is no introduction to how he arrived at his figures. It would be necessary to include a few additional sentences to explain this more thoroughly. However the most glaring fault with the paragraph lies in his use of the 20% tolerance range. This range went out with radio sets in the 1950's! I don't think a 20% resistor has been made for the past 30 years! Maybe it is a simple analogy to use, but if you are talking technically to beginners, they can just as easily comprehend an up-to-date manufacturing code, as a 30 year old code. I would suggest the 2% or 5% range but let's standardize on the well-know 10% range.

As with all manufacturing processes, the manufacturer does not want to waste any of the components. This means there must be a reasonable deviation either side of the spot-on value, which must also be accepted. Resistors are no exception. They are made in a continuous process in which the operator is aiming at say a 1k resistor. If you were to test these, you would find some could measure as high as 1.5k and others as low as 500 ohms. (This is only an analogy. In practice they would not deviate to this extent).

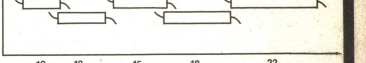
Any values outside this range may indicate a particularly bad fault in the end-termination or moulding or cutting process. In this case the machine would be stopped and corrected. Let us suppose all the components lie in the range stated above.

The point brought out in the second paragraph is valid. Continue along the same lines with a 10% range. Refer to data sheet No1. for the preferred values from 10 ohms to 100 ohms. The third paragraph should also be re-worded using the 10% range. Begin something like this:

The manufacturers of components decided to make a more logical system; without any overlapping, waste or missing values. The answer lay in an easy-to-understand 10% tolerance system. If the first value selected is 10, the top tolerance would be 11. The next value would need to have its lower tolerance very close to 11. This value would be 12. Now continue on... Just extend this reasoning up to 15 or 18.

Above the third paragraph is a sketch or graph. Its main fault lies in the ascending heights of the bars. These have no relation to the graph and are mis-leading. It is always an advantage to make the graph into a pictorial such as a circular graph (Pie Graph) or cutting up a component such as a map or dollar sign into pieces, to carry your message more clearly and more rapidly.

My suggestion for a 10% PREFERRED VALUE CHART is this:



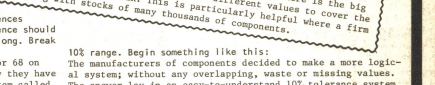
Re-write the third paragraph without using the word 'that'. Tidy up all your sentences and make sure they flow from one to another. Keep the theme consistent in each paragraph. Round off the article with one last concluding sentence. Your final versions need not be sent in to us. In fact, we wouldn't know how to cope with five hundred essays! You will merely have to keep them tucked into the back of the magazine and refer back to them at a later date; to see how much you have progressed.

Contributions to these pages will be most welcome, either of the original variety or a composite article with technical improvements.

Have you ever wondered why the values of components such as resistors, capacitors and even some inductances are given in what appear to be odd numbers such as 22, 47, 68 and so on? Actually the numbers are very carefully chosen, and are part of a system of what are called "PREFERRED VALUES".

In the early days of radio the values of components were given what might seem to be normal values, 10, 20, 30 and so on. But if we look at these values we see they are not very logical after all. If we look at the older series of values we see that the first two, 10 and 20, go up by 100%.So with 20% tolerance components there is a large gap - between 12 and 16 - where there is no value available. At the other end, 90 to 100, we find that a low value minus 20 % gives 80, while the 90 plus 20% gives 108. So we have the silly situation where a low value component can be lower than a 90 value component.

So the manufacturers of components decided to make a more logical system, where the next value began where the previous one stopped. With a 20% tolerance the 10 value could vary from 8 to 12, so the next value was chosen as 15. The bottom value tolerance of this would be 12, which is the top tolerance of the 10 value. The top tolerance of the 15 value would be 18, so the next value chosen was 22, where the bottom tolerance would be 17.6 - very nearly the same as the top tolerance of the 15 value. And so the series goes on 10, 15, 22, 33, 47, 68, 100 and so continues always going up by the same ratios. If we want more accurate tolerances, say 10% or 5% then we have intermediate values based on the same principle.



20% "PREFERRED -VALUE" SERIES

The sketch above shows how the components with this new arrangement cover the full range without overlapping, and they all have the same 20% tolerance. Apart from avoiding the situation that was mentioned above where a 90 value high-tolerance component could be higher than a 100 value low tolerance component there is the big advantage that instead of needing nine different values to cover the range we now only need six. This is particularly helpful where a firm is dealing with stocks of many thousands of components.

series

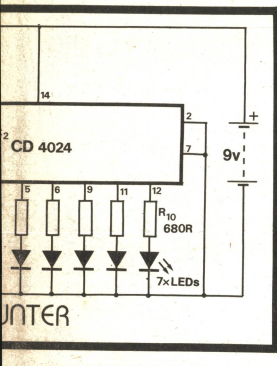
ER BOARD

UNTER

J.Petroulias

After building project six

Project cost: $3.50



Parts List

R1	resistor	100k ¼watt
R2	"	3k9 "
R3	"	22k "
R4 to R10	"	680R x 7
C1	electrolytic	2.2mfd 16v
IC1	timer IC	NE 555
IC2	binary counter	CD 4024
LED_1 to LED_7	large red LEDs	

battery clip
9v battery
push-to-make switch
molex pin
hook-up wire

"Experimenter Board 3-ICs"

Circuit Operation

The 555 and its associated components form an astable multivibrator with a frequency of about 2Hz(1 pulse every ½second). Depending on the position of Sw_2 the counter will receive auto pulses or manual pulses. R_1, R_2 and c_1 set the frequency for the "clock". The 555 has also been arranged as a one-shot with triggering from Sw_1. When Sw_1 is pressed, the short on pin 7 is removed via the internal working of the 555 and capacitor C_1 begins to charge. As the voltage rises to 2/3 of the supply voltage, pin 6 detects this and cycles the 555 to produce a single pulse for the 4024 IC. At the same time pin 7 becomes connected to ground and the capacitor begins to discharge through R_2. A portion of this discharge time forms the maximum cycling rate for the 555, so no matter how fast the push-button is pressed, the clocking rate will be a max. of about 2Hz. This circuit is not designed for interpreting high-speed input pulses, and should be kept for low-repetition manual operation.

The intention is for you to input a specified number of pulses and read off the result from the illuminated LEDs. You can check any value from the complete table on either side of the article. This is an ideal aid for learning the BINARY TABLE.

Assembly

Some of the components from project six can be left in place, others will have to be removed or re-positioned. Follow the lay-out diagram for the position of each component. Fit all the jumper wire first, then the components and finally the IC. Switch the game to auto, connect the battery and the IC will start to count.

Once you have mastered the BINARY TABLE, or have sufficient understanding to be able to make your own, you can use the project in the auto mode for a visually pleasing display.

Making Sw_1

The change-over switch Sw_1 selects either auto or manual clocking. It is made from 2 molex pins and a flying lead. Since this switch is used on very few occassions, the molex pins will be quite sturdy enough.

Problems

Pulse your counter 28 times and read the LEDs. Confirm your answer from the table. Try these: 57pulses; 89pulses; 102pulses; 128pulses; 152pulses. What do you notice about the last two?

Can you find the mistake in the BINARY TABLE running down the outside edges of this page.

DECIMAL NUMBER:	BINARY NUMBER:
64	1000000
65	1000001
66	1000010
67	1000011
68	1000100
69	1000101
70	1000110
71	1000111
72	1001000
73	1001001
74	1001010
75	1001011
76	1001100
77	1001101
78	1001110
79	1001111
80	1010000
81	1010001
82	1010010
83	1010011
84	1010100
85	1010101
86	1010110
87	1010111
88	1011000
89	1011001
90	1011010
91	1011011
92	1011100
93	1011101
94	1011110
95	1011111
96	1100000
97	1100001
98	1100010
99	1100011
100	1100100
101	1100101
102	1100110
103	1100111
104	1101000
105	1101001
106	1101010
107	1101011
108	1101100
109	1101101
110	1101110
111	1101111
112	1110000
113	1110001
114	1110010
115	1110011
116	1110100
117	1110101
118	1110110
119	1110111
120	1111000
121	1111001
122	1111010
123	1111011
124	1111100
125	1111101
126	1111110
127	1111111

SHOP TALK

— CONDUCTED BY THE EDITOR

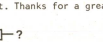
Our intention is to use readily available components in all the projects. This is easy for the simpler projects but becomes difficult when we design more complex circuits. This problem has arisen with the "AND" display for the counter module. Currently we lack a wide choice of multiplexed displays on the Australian Market but this is gradually being remedied as new lines are being imported by distributors. Our sample of the "AND 4145R" was received from the sole importers of "AND" LED displays, Stewart Electronics, 44 Stafford St., Huntingdale 3166.
Unfortunately there is no direct substitute for the AND 4145. We chose this display for its neat construction and easy readibility. Although these displays are fairly expensive, their advantage becomes apparent when connecting them to the PC board. It is extremely difficult to combine more than two 7-segment displays such as FND 500 and impossible to connect FND 357's together as the terminating pins run down the side of the units and allow insufficient room for solder lands and inter-connecting wires to be added.
The "AND 4145" is one of a range of displays made for "AND" of America by large assembly lines in Japan. They buy LINE-TIME from under-producing manufacturers and specify custom-designed components to be produced. This satisfies both parties. The manufacturer increases his line-time and can offer this time at a substantial saving. "AND" can then afford to compete on the market with first quality components. The "AND" displays are one such line. They offer extremely good clarity and evenness of segment illumination down to 10ma for the whole 28 segments. This brightness is due to multiplexing as the segments are pulsed for a very brief period of time with a high current and this produces a much higher-efficiency glow. The 10ma we are reading on the multimeter is only an RMS reading and does not take into account the pulsed contitions.
The sublimality (hidden-ness) of multiplexing the display will be revealed in our project next issue. By slowing down the scan rate with an adjustable 4553 IC, we will be able to see how the individual segments are strobed. You may use either your own home-made display or the "AND" display.

PARTS AVAILABILITY

We have really started something new with our back-up services. The fact that almost all the parts will be available through the network of Australia-Wide list of Stockists has already begun to show signs of feed-back. Eventually we will distribute complete kits of parts to each of these stockists, including the printed circuit boards, a few days before the magazine is due to appear. Unless you pester your local electronics shop, he will not be able to gauge the potential of this venture or know the quantity of kits to order.
Electronics is growing so rapidly that not only will the already established resellers be extending their range of stock, but a number of progressive operators have already considered expanding their operations. Three which come to mind are: Altronics of WA, Dick Smith (naturally) and Ellistronics.
Jacar has recently been put in the adept hands of Gary Johnson as it look like he will make the operation flourish. See their advert in this issue.
At the moment you will need to shop around as any individual firm does not, and can not, carry the full range of electronic components, kits or every piece of equipment imported into Australia. We have therefore to bring you a selected list of suppliers to cover the needs of the magazine and also the requirements of the more advanced individual experimenter. It would be appreciated if you would inform us of your local stockist if he is not already included on our list. Similarly, any supplier on our list who does not live up to expectations or caters for other electronic fields, could also be mentioned.
Since electronics is expanding at a phenominal rate, it would not be excessive to expect your local supplier to expand by 10% to 20% in the remaining part of this year. This will come about not only due to the sales generated by the magazine but by the increasing awareness of schools, students and firms. Some increase will be attributable to our new range of exciting kits and the fact that many readers have carried out my initial comments about making at least one project from each issue. Actually numerous readers have placed orders for every kit and PC board on the order form. This has highlighted the crying need for new progressive kits in the low-price bracket. In future we will be combining a number of projects and extending the basic kits to form more elaborate projects.
With this approach you will be able to construct a large model without feeling the 'bite'.

LETTERS

Mr MacGregor has sent an addition to the article in issue No 2 on REMOVING IC's. He has had experience in this field and suggests a more suitable method of removing the solder is to involve one of Newtons Laws, He writes:
"If a solder-land is heated with the soldering iron and the PC board tapped sharply on the workbench, the molten solder will keep going. Try it! After a few experimental taps, you will find Newton is correct. You will finish up with a solder-free solder land. To release any remaining grip, move the wire with a screwdriver. It will then become completely free. The IC can then be plucked from the board with your fingers.
Many thanks for this suggestion. I think it is an ideal method. I have not tried it myself as it is completely taboo when repairing large printed circuit boards under normal situations. The reason why you should not allow the unwanted solder to flick off any of the solder-lands should be quite obvious. Each of the solder may bridge a connection elsewhere on the board and produce an additional fault. This would be extremely hard to detect and just multiply your problems. However on an unwanted PC board the tapping method is ideal.
Another letter on this subject arrived from Mr Mackrill. I'm not sure whether he is taking us for a ride or not. We enjoyed his letter so much, I'll present it in full. He writes: "I am a newcomer to electronics and have found your first two editions very enjoyable and informative. After reading the column on removing IC's, I tried the method but found it very difficult to get the Alfoil to stay put. This was my first attempt at removing an IC and I gave up in disgust. After a bit of a think, I thought of using a Utilux 25amp battery clip. After grinding the teeth off so that both the jaws were flat and parallel, found it was just the right size to go on a 14 pin IC and short out all the pins. Putting the board in a vice and applying heat to the pins with an Oxy-Acetylene torch, the IC came off the board very quickly; with the clip acting as a heatsink to the extent that the body of the IC barely had time to get warm. I have removed a Schmitt Inverter and a 4011 using this method and put them onto another board with excellent results. (They still work) I have found this method much easier than trying to get the Alfoil to stay put. Thanks for a great magazine."

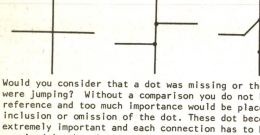


We must be the first magazine to have a double standard. With resistors, that is. We have decided to satisfy both parties and present some our circuit diagrams using the well-known zig-zag symbol and include one circuit using the "BOX" symbol. This is introduced as a trial to gauge further reaction as the letters received to date have been quite interesting. Almost all those received were in favour of the zig-zag symbol. This may be a biased result as those preferring the new style may not be particularly vocal or literary. This is generally typical when a change is taking place or about to take place. In our case, those hobbyists being brought up on the new box symbol are young beginners, not too intent on expressing an opinion.
After ringing a number of organisations, I learned that High and Technical schools are becoming more involved in electronics and their courses specify the new box symbol.

Instructors are required to teach these new symbols and it seems their efforts are most noticeable in the younger sectors. We are seeing it too, in the circuit diagrams being sent in as project material.

One interesting point was expressed by Mr A. Macgregor. He writes: "When Mr. T. Baitch sits down and works out an electronic circuit in the rough, does he spend time drawing little boxes for resistors? Perhaps he does. Nobody else would waste this time."
A number of other letters followed along the same lines. I must be fairly impartial and consider the answer would depend on which symbol was your introduction to circuit drawing. Accordingly young hobbyists might, in fact, draw the circuit using box-type resistors.

Maybe we have accepted to dual resistor symbols, but no amount of talking or persuasion will bring us to accept the symbol for non-connected wires. We don't consider this symbol sufficiently clear. Suppose you had only one jumper in the diagram and it appeared as in the first sketch.



Would you consider that a dot was missing or the wires were jumping? Without a comparison you do not have a reference and too much importance would be placed on the inclusion or omission of the dot. These dot become extremely important and each connection has to be physically examined in the circuit diagram to determine if a connection is intended. There are two better methods of distinguishing between a connection and a non-connection. These involve staggering the wiring to produce a "Tee" intersection so that a cross-over is represented with a dot and connected wires are represented with two dots.
The only time I will accept directly crossing wires without a dot applies in matrix diagrams. With so many wires passing over each other, it would be virtually impossible to include bridges.

ORDER FORMS

The inclusion of an order form and parts list in each issue has kept our despatch section neat and efficient. It is considerably faster to process a printed order form over a hand written note as we arrange our shelves to match the printing. Some readers are still reluctant to cut out the order forms in case they lose the information on the reverse side, albeit only SHOP TALK or PUZZLE PAGE. Unless we leave the reverse side blank, I do not think we will ever be able to overcome this situation. Some readers problems are compounded as they do not have access to a photocopying machine and must resort to hand copying.
I realize this is particularly upsetting if you wish to send for the transistor offer. I have a solution.
Write your name and address on the coupon then photocopy it! You may combine both coupons onto the one photocopy.

WHICH BOX?

Last issue we presented a table showing the comparisons between three makes of project boxes. These boxes are generally fairly expensive and in some instances, exceed the cost of the electronics they house. After a little searching and help from readers, I discovered that you could provide an enclosure for a project at a considerably reduced cost. Obviously the finished product would not be as 'classy' nor as rugged but the savings may be of greater importance.
The range and availability of alternate housings falls into three categories:
1. Adaptions and modifications to household containers.
2. Purchase of suitable 'asthetic' containers intended for any use other than electronic.
3. Purchase of basic constructional materials to make a box.

If you look around your own home you will find a dozen or more suitable boxes just waiting to be filled with an electronic circuit. Look especially for cosmetic containers and presentation containers. Food containers or sewing kits or sports boxes such as fishing tackle boxes can be used. I found three ideal boxes in our local bank; the last place you would expect to find a project box. These money boxes are supplied by the ANZ bank and consist of two similar halves, the base being a hexagon with six sloping trapezoidal sides. If you bank at the ANZ, get a couple of these boxes. They form an ideal project box and we intend to use them in the next issue for a great project. The quality of the plastic is superb and for $1.00 you get a 14-sided money box which can be split into two or clipped together for a large project. The slot in the top will accept a slide-pot or 20c coins and the money you save by using this project box can be banked with Mr ANZ.

Finally, the third method of obtaining a cheap project box is to buy the basic materials and hand-fabricate it yourself. One popular method was suggested by Mr J. Ritchie. His pupils purchase PVC downpipe 100mm x 50mm and cut it to length. It is amazing how many boxes can be cut from the rectangular section. The ends can be made from either pine, particle board or plastic. You can use special PVC glue to attach the ends or screw them into the PVC with small self-tapping screws. The PVC downpipe costs about $6.00 and the glue about $2.00
Don't say you can't find a project box, just use your imagination and look around your own home.

oooooooooooooooooo

Well, once again I'm rapidly running out of room. I've got just enough space to give you the answers to the Basic Electricity Course and some corrections which have come to our notice regaurding issues 1&2.
I have had to hold over a number of projects till next issue due to the unavailability of specialized parts. I hope this situation will improve as we intend to produce projects using IC's other than run-of-the-mill types.
Maybe it will improve as Japan is coming on the market with an expanded range of even lower priced integrated circuits. While speaking of IC's, I would like to clarify a point contained in the Editorial of issue 2. Obviously I was referring to the 20-watt stereo chip itself for $5 and not the completed amplifier.
As from the next issue I will separate LETTERS from the general discussions in SHOP TALK and present them in the depth they deserve.

FURTHER CORRECTIONS TO ISSUE No1

Two further corrections have come to my notice.
Page 11: The 4.7mfd electrolytic in the LED Zeppelin circuit should be reversed. The positive lead connects to pins 4,8 and 9 for guaranteed starting. Strictly speaking, the electrolytic should be non-polarized as the voltage reversals are as high as the charging voltage.
David Willing, 3104, found the symbol for the CD 4001 in the LED Zeppelin circuit to be incorrect. He could not get the circuit to oscillate and substituted a CD 4011. It worked perfectly. On re-fitting the CD 4001 and turning the 4.7mfd electrolytic around the other way the circuit once again began to oscillate. Note this fact on the LED Zeppelin diagram immediately.
P 30. The MINI AMPLIFIER diagram has a wiring mistake near the 100mfd electrolytic driving the speaker.
The 1k5 load resistor should terminate on the negative side of the electrolytic, next to the speaker and NOT the positive side. It is presented correctly in issue No 3, under the heading: LISTENING BUG on the TRANSISTOR PAGE.

If the LED Zeppelin does not oscillate, replace the 4.7mfd electrolytic with a low loss type.

CORRECTIONS TO ISSUE No2

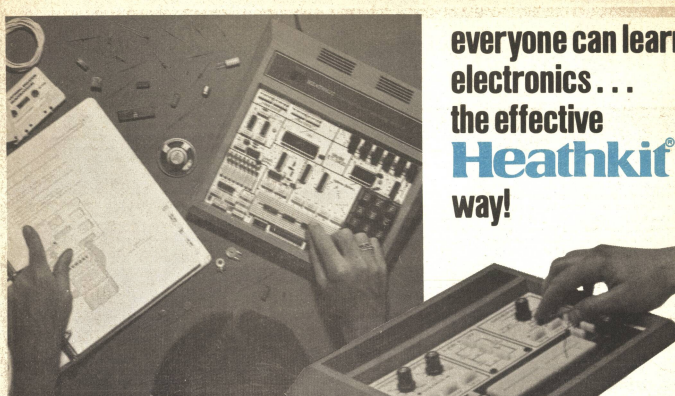
P 19: WHICH BOX? The small Zippy and Jiffy box should be UB5.

Answers to BASIC ELECTRICITY

P.14. 0.005A, 2.34A, 10,000V, 3,470,000 ohms
100v, 20,000 ohms, 5.3A, 0.68A.

P.15. (a) 0.2A (b) 144v R_t = 48.5 ohms
I = 2amps I_a = 1 amp I_b = 8.75amp
V = 4volt

P.17. (a) R=1k1,)b) R=6k6 (c) 1,175 ohms
(d) 6k6
R = 9k9 R = 2,350 ohms R = 2k2
R = 1,320 ohms R = 2,480 ohms
R = 1,498 ohms R = 767 ohms.



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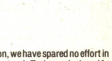

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WF TST 100

TV Servicing Part II

by our staff serviceman

Our previous article on TV servicing outlined fault-finding dry joints. This month we continue along the same lines, with the next stage in simple repairs.

As with every type of profession, a great deal of skill is needed to solve even a seemingly simple task. As I gradually phase out of TV servicing, I wish to pass on my accumulated skills to the next generation of servicemen. This article is not designed to put already established servicemen out of business, nor will it be sufficiently comprehensive enough for you to go off boldly and start repairing TV's. What it will provide is, a collection of readily available facts as a back-up for that time when you get landed with a problem set.

Many colour TV faults present themselves time and time again. A particular fault will show itself in the whole batch or series of sets. This means each brand has its own list of special faults. Generally a serviceman can predict a fault before he takes the back off the set. Obviously this means he has tackled the fault previously. But how does he handle the situation on his initial attempt? Only time will tell. He must use his collection of skills to their fullest and gradually eliminate each component, one at a time.

Climb aboard and come with me on a few of the jobs carried out last month. See my reasoning and approach to the problems. This will not be an "in-depth" coverage, just a collection of related faults. This list could go on indefinitely, so let's pick out just a few.

IT's JUST A FUSE!

How often have I heard the customer say "It's just a fuse! Bill, down the road, had the same fault and his set just needed a fuse."

Well, maybe it does just need a fuse. But nine times out of ten the set will contain a fault which caused the set to fail. You see, to an experienced technician a fuse can fail in three ways. Let me list them:

1. The first case is fairly uncommon,but it does happen. The fuse wire inside the glass tube will fracture at one end, inside the end-caps. The fuse will still look to be perfect since the break is hidden, but a multimeter will show it to be an open circuit.

2. The second occurs through general fatigue. The fuse wire gradually oxidises over a period of years and finally fails for no apparent reason. This over-stressing occurs when the set is turned on. The current rushing into the power supply can be in the order of 10 amps or so for the first few cycles. You will be able to see the fuse stretch and sag as it absorbs this high current. Obviously it will not take this treatment for ever, and finally it fails. One way of overcoming this problem is to fit a DELAY fuse. It consists of two pieces of wire with slightly higher current rating, soldered in the middle with a dob of solder. This type of fuse will still weather slight surges yet fail at the specified current flow by melting the solder.

There is another style of delay fuse which deserves a mention. It consists of a coil of wire similar to the filament of a lamp. It has a special style of failure all of its own. The added heating-effect of this coil can cause to wire to burn through after many hundreds of stressing, even through normal use. The break is very hard to see with your eyes and you can quite often be trapped. Always test fuses with a multimeter set to low ohms range.

3. The third case is quite obvious. It's the case where the fuse has exploded with such violence that the glass tube has shattered into little pieces all over this inside of the set. The only parts left are the two end caps, firmly welded to the fuse clips! You couldn't mistake that a dead short has taken place!

From these three tell-tale signs, you will be able to interpret which parts of the power supply will also need replacing.

In the first two cases I would suggest testing the four bridge-rectifier diodes before replacing the fuse, to confirm if they are ok. In the third case, I definitely suggest testing the four diodes. To test them for complete shorts, you will need to lift one end of two diodes from the board and check each diode individually with a multimeter set to high ohms range. The capacitors across each diode should also be checked, especially in Luxor sets. The posistor driving the degaussing coil can also cause the fuse to blow. See it explained later. Quite often you will find only one or two diodes have been affected. It will depend on the severity of the spike entering the supply. Replace the damaged diodes with 600 volt types, having a current rating of 3 amp.

I suppose you are wondering where a high voltage spike could come from? Would you believe it comes from a flash-over at the point where the EHT lead enters the picture tube. The high voltage appearing at the instant of turn-on sees the picture tube as an uncharged capacitor. This EHT is capable of jumping at least 7cm across the outside of the tube and piercing the relatively thin insulation on the degaussing coils, placed around the tube. Any small amount of dirt or cigarette tar-tar will increase the spark ten-fold.

This is especially dangerous on cold, damp days when the corona discharge appears as fine lightning flashes from the EHT button. The possibility of flas-over is most acute under these conditions. The pulse travels down the degaussing coil to the input of the power supply and appears as a powerful high-voltage spike. This is capable of puncturing the power supply diodes quite easily. It is the voltage which destroys the diodes, not the current.

SILICONE SEALANT

With every colour repair, one of the first preventative measures is to seal the EHT cap. Before removing the EHT lead, you must make sure the set has been off for a minute or so. The most satisfactory method of discharging the picture tube is with the earthing spade provided, or with two long-handled screwdriver in contact with the earthing strap on the back of the tube. It is important to avoid a large spark or zap as you could create enough flash-over to destroy the transistors in the tuner or the power supply. To reduce this spark, the tripler lead (which contains the corona cap) can be unplugged and touched on the back of the tube, then taken back to the input hole. This will recharge the capacitor in the tripler ready for the second recharging. This should be repeated a number of times until the spark becomes small. The tube can then be fully discharged with a jumper lead clipped to the earthing strap on the back of the tube. Clean around the hole with a dry rag and apply Selleys silicone sealant to the button and the circular sealing rim of the corona cap. Fit the cap onto the tube and smooth off with your finger. At the same time build up the insulating layer around the cap. Blaupunkt and Nordemende sets are specially prone to damaging the power supply after a flash-over.

REPLACING THE FUSE

It may now seem a simple matter replacing the fuse with anything of a higher rating. But you will be wrong. A great deal of thought has gone into which type of fuse is needed for a particular set. Four different types of fuses are used according to the stress placed on them when the set is turned on. Transformerless sets such as Blaupunkt demand the heaviest surge currents as they do not have a mains transformer to buffer the input current. For this reason they need 3.15 amp or 4 amp fuses. Nordemende, with the same arrangement, specifies 5amp. Japanese sets with mains transformers use 2 amp fuses. It is important to replace the fuse with one of the correct rating as it performs a demanding role and must be ready to act when an overload occurs yet not burn out un-necessarily.

DEGAUSSING

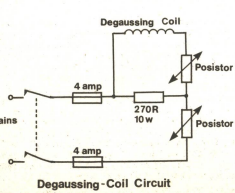
I mentioned the degaussing coil. What does this coil do? Possibly you are aware of the shaddow mask, located about a couple of cm behind the picture tube screen. This mask consists of up to 500,000 fine holes through which each of the three electron beams pass. The operation of the shaddow mask can be likened to this situation:
Three metres from a sliding door, position three people in a row, and three symmetrically on the other side of the door. Close the door, making a 30cm slit. You will find that each person will be able to see only one opposing person through the slit. This equates to the three guns, the hole in the shaddow mask and the three dots of phosphorus on the inside of the picture tube. Since electrons are highly susceptable to magnetic and electrostatic influences, the slightest magnetic retention in the mask will deflect the electron beam a fraction of a millimetre and it will hit the next-door phosphor dot. This will be a dot of incorrect colour as each of the three dots form a triangle called a triad. The most critical colour change is with the red beam. If this beam is deflected ever-so-slightly, the red portion of the picture tends to show as pink or yellow. This is most noticeable on faces. As the actors move across the screen, their faces change colour! This fault is a gradually worsening symptom which is created by one of three factors:
1. Shifting of the shaddow mask. This shaddow mask is sprung on a heavy frame within the tube to allow for thermal expansion and contraction. If the set is dropped or bumped, it may come out of alignment.

2. External magnetic influences such as large speakers, or children with magnets, can create large magnetic spots on the screen.

3. Failure of the de-gaussing coil and its associated turn-on components.

HOW THE DEGAUSSING COIL WORKS

Every TV takes a fraction of a second for the picture to appear. In this blank time, the coil of wire around the periemter of the back of the tube is subjected to a very high current. This fades to zero in the space of 1sec. its effect on the mask is to stir up the magnetic particles and orientate them in a completely random pattern. As the magnetic flux reduces, the residual magnetism in the mask becomes zero. This occurs every time the TV is turned on from cold. It is achieved by two positive-temperature-coefficient thermistors, contained in a three-leaded package. On turn-on, these thermistors are very low resistance, and most of the current flows through the de-gaussing coil.
This heavy current heats them up rapidly and causes their resistance to rise. This causes the current in the coil to reduce to near zero. It is kept near zero during the operation of the set by the 270ohm bleed resistor keeping the posistor slightly warm. Posistor #2 is situated next to posistor #1 and effectively keeps to degaussing coil turned off.
Normally you would never see the effectiveness of the de-gauging system, but it can be viewed by setting up this experiment:
Remove the de-gaussing coil plug and re-connect it via a switch. Turn on the cold TV and close the switch while watching a test pattern. You will see the screen break into pretty patterns, similar to oil colours on water and any little tinges of pink or red will disappear. If nothing occurs you should suspect the posistor.
Because the posistor has an extremely small cold resistance, it is possible for it to blow the mains fuse. If you suspect this to be the case, remove the posistor for a week or so and run the TV set. It can be omitted without any detrimental effect.

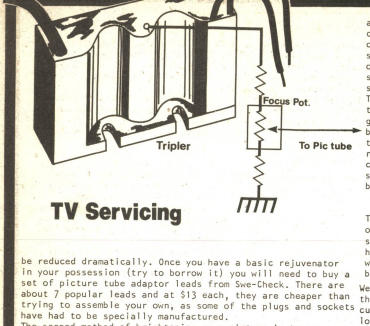


Degaussing-Coil Circuit

THE TUBE

Second-hand colour TV's are coming on the market in ever increasing numbers as the more affluent of us realize the necessity to up-date. Two factors have influenced this increase. Firstly: Many people who took out a rent-purchase or rental agreement are now in their fourth year of renting. They are tending to abandon the agreement in preference to owning their own new, up-to-date set.
Secondly: The majority of four-year-old sets are on their last legs and after two or three service calls, are tending to be left aside in an un-repaired condition for a new portable set.
One of the disturbing factors with colour television has been the ignorance of picture tube life. Most of the public, including the slick salesmen, considered a colour TV tube would have an exceptional life. They took their reasoning from quite relevant data, such as the life of their Stromberg-Carlson or STC black and white TV. They reasoned the life of their "good old set" was about 20 to 25 years and the picture was quite watcheable, so surely with improved technology, the life on any colour TV would be about 15 years! They knew nothing about the workings of a colour tube, the degree of drive needed to produce a watcheable colour picture or the quality of the tube. They just speculated on 10 to 15 years. Unfortunately there was no technical back-up from the manufacturers to enlighten them on this matter, nor has there been ever since! If the truth were known, many people would have considered a purely rental agreement.
What is the reason for this failure rate?
After a few years of average use, the quality of some colour picture tubes reduces to absolutely unwatcheable, while others remain almost perfect.
This is due to a combination of many factors. The tube itself, the degree of drive, the method of driving the tube, the number of hours the TV is viewed each day and any prolonged periods of non-use.
All these factors put together enable me to state two indisputable facts.
Almost all 43cm tubes are 100% reliable. (excepting Sony).
After 4 years, 63cm tubes will fall into two groups: very poor condition and nearly perfect condition.

Once a tube begins its down-hill decline, there is very little we can do. A rejuvenation may last up to six months or as little as one day. Two methods of improving the picture are available. They are only a 'stop-gap' measure and cannot be guaranteed. The first method requires a REJUVENATOR. These are extremely expensive and range in price from $295 to $485. You would need to 'hit' a lot of tubes to get your money back. It is quite easy to make your own unit for $40 to $60 and this will be detailed in a later issue if the demand is sufficiently large. It will be only a single meter type with switched inputs to read each gun in turn. Rejuvenators are of dubious value. They really have very little use and in fact I have found there is no connection between the quality of the picture and the reading on the machine. In fact the reading are quite unrelated. A tube may show only 2% emission and yet give a fairly good picture, while a poor picture has recorded a 28% reading!
Rejuvenators work in two different modes. Some rejuvenate the tube while the filament is still on, others turn the filament off before supplying a high voltage between cathode and first accelerating anode. By far the most effective time to electronically clean the cathode is when the filament is dying down. Otherwise the added heat produced by the blasting process, when added to the filament temperature, will tend to overheat the cathode, This will cause the whole gun assembly to expand and reduce the effectiveness of the blasting process. The time taken for rejuvenation will thus be increased and the cathodes electron emitting properties will



TV Servicing

be reduced dramatically. Once you have a basic rejuvenator in your possession (try to borrow it) you will need to buy a set of picture tube adaptor leads from Swe-Check. There are about 7 popular leads and at $13 each, they are cheaper than trying to assemble your own, as some of the plugs and sockets have had to be specially manufactured.

The second method of brightening up a picture is to use a PICTURE TUBE BRIGHTENER. Since the picture brightness is heavily dependent upon the ability of the three cathodes to emit electrons, it follows that an increase in cathode temperature will greatly increase this flow and brighten the screen. Normally the tube operates on 6.3vAC. We can increase this voltage by up to 4v with a reasonable degree of safety. Colour TV's derive the 6.3v from one of two sources. Either a special tapping on the power transformer, or a winding around the core of the EHT transformer.

If your set is the former case, you will need a small transformer such as #169 from Swe-Check. It is a flying-leaded auto-transformer which can be fitted to almost any set. The instruction come with the unit. As an alternative, I fit a complete power transformer type 2155. It has voltage tappings from 6v to 15v and is wired back to the mains switch. If the set suffers from an open filament, this transformer can be used. Firstly you will need to heal the filament by tapping on the neck of the tube. If it begins to glow, you can be assured it will stay alight. The only danger is turning off the set. Most of the damage with colour picture tubes occurs not during the operating time but during the period when it is not used. This is the reason why families with large TV appetities find their set lasting a long time. If the filament were to be kept alight all the time, it would not suffer from open cathodes and open filaments. It is the heating up and cooling down which stresses the spot welding in the gun to create intermittents. By wiring the transformer back to the incomming power lead, we can arrange the filament to be on 24 hours a day. That is, providing the customer does not turn off the power at the power point!

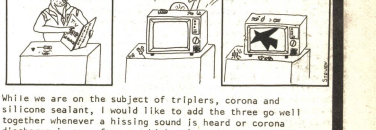
If the filament voltage is derived from a winding around the core of the EHT transformeras with Philips and HMV sets, it is a simple matter to remove this winding and replace it with one having a few more turns. I generally rewind the winding with ordinard hook-up flex and add 3 more turns. The ends are taken directly to the tube. It does not matter in which direction the winding is wound. A small wire-wound resistor of about 2.2 ohms (2R2) is included in one lead to prevent the picture tube burning out on turn-on. Watch the glow of the filament and compare it with the original glow. Reduce the number of turns to compromise between picture quality and excessive glow. If the filament is too bright, the remaining life of the tube will be used up in a matter of weeks.

FOCUS VOLTAGE

Once the tube has been brightened up you will need to adjust the focus. This voltage is generally picked off the tripler as the first rectified voltage. It emerges at approximately 6 to 8KV DC and a voltage divider network is provided by the focus pot in conjunction with upper and lower limiter resistors. Most tubes require a potential of about 4.5kV for sharp focussing. When adjusting the focus control we keep the picture at full scan and look at the centre of the picture. Rotate the focus control to either side of the optimum point to make sure it is in the centre of its range. If it is completely one-ended, follow these steps: it is difficult to measure the voltages in this stage as they are above the maximum range of most meters. To extend the range of say a 30k/volt meter, you will need to add a 4M7 resistor to the positive probe. This will not give you an accurate voltage reading but rather a comparison between each circuit point. You will not need to actually touch the high voltage points with the resistor as it will readily receive spray as the DC voltage has a high-frequency component. The length of the corona discharge will be a sufficint comparison. The low side of the focus pot should be about 3kV and the high side about 5kV.

The most common fault involves the upper resistor burning out. Well not actually burning out, that's just a figure of speech. It tends to 'track' and go high. This is due to the high voltage appearing across it. An open focus resistor will not only give poor focus, it will cause the picture to become very dark, or even totally black.

We call the focus circuit a high impedance circuit, meaning the resistors are in the order of meg ohms. This means the current flowing through them will be only milliamps. Any loading on the circuit such as leakage or a multimeter, will reduce the voltage appreciably. Three brands of sets have a fault which does just that. They have a 5kV spark-gap across the feeder line to the focus anode. If this gap becomes dirty it will reduce the focus voltage very slightly and create an intermittent focus fault. Sets prone to this fault are: AWA, Luxor and Nordemende. All that needs to be done is clean the spark gap. If corona has damaged the insulation, it will need to be replaced. Don't leave it out.



While we are on the subject of triplers, corona and silicone sealant, I would like to add the three go well together whenever a hissing sound is heard or corona discharge is seen from any high voltage point. Corona concentrates on projections, in other words, the discharge into the air is enhansed by the slightest spike of soldering or piece of wire protruding from a connection. Always cover these bare joints with silicone sealant - it may save you the cost of an expensive component in the long run. I have replaced a number of triplers and focus pots merely through corona discharge causing tracking right down the component to earth. The passage is aided by dirt, fluff and cigarette tar to the extent where up to a 5cm track was formed...damaging the component completely. A stich in time.....

A number of other rather simple faults involved my skill, in-between these faults. Their solution was simple but they proved a challenge at the time. Five of them were dry joints; one in the edge connector socket, one being a capacitor lead, one turned out to be a faulty push switch, one a faulty fuse and the most recent turned out to be the moulded power plug. These are items you do not readily expect and pin-pointing them can take extra time. Take the three cases where the customer worsened the fault by taking the back off the set and "trying his hand." Two even tried to re-converge a perfectly converged picture! ...with disasterous consequences. To re-converge the picture can take an inordinate length of time, and becomes an almost impossible task, especially when the customer has turned every knob with in his reach.

So, all in all I had a fairly busy, active month. I have a number of interesting points to bring up on the more complex jobs. These will be discussed in the next article.

THE TRANSISTOR PAGE

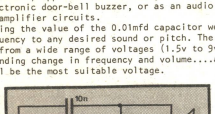
Use Your 2 FREE Transistors in These 3 Simple Projects

1 MULTI-PURPOSE OSCILLATOR

by G. Khalil. 2148.

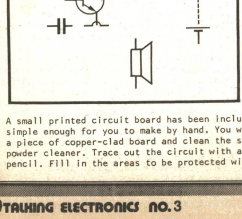
This multi-purpose oscillator is a two-transistor directly-coupled amplifier with very high gain. The output is coupled back to the input via the 0.01mfd capacitor to give positive feedback. The frequency of oscillation is set by the 100k resistor and the 0.01mfd capacitor. It can be used in a number of handy applications including a morse-code practice set, electronic door-bell buzzer, or as an audio signal for testing amplifier circuits.

By changing the value of the 0.01mfd capacitor we can alter the frequency to any desired sound or pitch. The circuit will operate from a wide range of voltages (1.5v to 9v) with a corresponding change in frequency and volume....about 3v or 4.5v will be the most suitable voltage.



OSCILLATOR

This circuit is actually a re-arrangement of the TICKING BOMB project in issue No1. The only two components which have been altered are the 2.2mfd electrolytic and 100mfd electrolytic across the battery. Your first task is to re-draw the circuit according to our standard convention so that the layout becomes more self-evident. To help you, the individual components have been drawn in their correct positions. You will need to add the connecting wires to complete the circuit. Check your drawing accuracy by comparing it with the circuit on P29 of issue number one.



Oscillator P.C. Board

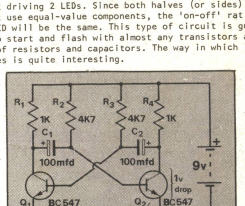
Finish This

A small printed circuit board has been included which is simple enough for you to make by hand. You will need to cut a piece of copper-clad board and clean the surface with a powder cleaner. Trace out the circuit with a black-lead pencil. Fill in the areas to be protected with a spirit pen such as Dalo or Edding 3000 or you can use nail polish or nail lacquer, in fact anything which is not water soluable and which will resist the ferric chloride etchant. Refer to the article on making your own printed circuit boards for the etching times and precautions. Drill all the holes with a 1mm drill. Insert the parts as shown in the layout diagram and connect the battery, speaker and switch. It's so simple its almost guaranteed to work. Experiment with changing the frequency by placing your fingers across the capacitor and resistor. You may substitute either component to obtain any desired frequency.

• • • • • • • • • • • • • • •

2 LED FLASHER

The LED FLASHER circuit is a square-wave or multivibrator circuit driving 2 LEDs. Since both halves (or sides) of the circuit use equal-value components, the 'on-off' ratio for each LED will be the same. This type of circuit is guaranteed to start and flash with almost any transistors and any value of resistors and capacitors. The way in which it operates is quite interesting.



Led Flasher Circuit

HOW A MULTIVIBRATOR WORKS

When the battery is connected, both capacitor begin to charge up. The charging path for C_1 is: R_1; the base-emitter junction of Q_2 and the second LED. The equivalent components charge C_2. This action puts a forward-bias on both transistors and they both immediately try to turn on. Fortunately, due to component tolerances and transistor switching times, only one of the transistors will win. Suppose transistor Q_1 wins. This action will effectively bring the 100mfd electrolytic C_1 down towards the negative rail, in fact, about 2.7v above the negative rail (made up of 1.7v drop across the LED and 1v drop across the transistor as shown in the circuit diagram). Now C_1 will have charged up slightly during the initial turn-on period and say it has charged to 3v. This will be just like placing a 3v battery from collector of Q_1 to the base of Q_2. The base of Q_2 will see a resultant voltage of 2.7v minus 3v or -.3v This will turn the transistor "hard-off". C_1 will now begin to lose its charge via R_2, Q_1

and the first LED until the forward bias provided by R_2 begins to turn transistor Q_2 on. This tends to bring down C_2 and in doing so, turns off Q_1 and raises the voltage on the positive end of C_1. This change-over action occurs very rapidly and it is basically the 'discharge-time' which determines the duty-cycle or frequency of oscillation.
If you can visualise two points, you will begin to understand the operation of a multivibrator.
Firstly consider the electrolytics as miniature re-chargeable batteries and secondly; mentally position them alternately above and then below the transistor. This way you will be able to see how they are affecting the opposite transistor.

CONSTRUCTION

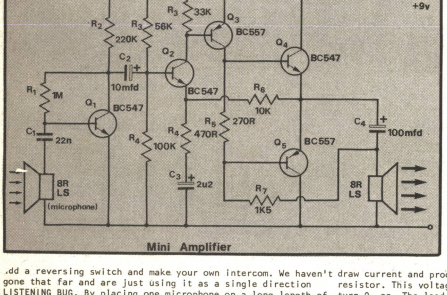
This circuit can be built on a piece of veroboard and since it doesn't have an on-off switch you will be able to solder it directly to an old 6v lantern battery. It takes very little current and will keep flashing for many days before the battery finally becomes exhausted.

• • • • • • • • • • • • • • • •

3 LISTENING BUG

A. Hellier, 2281.

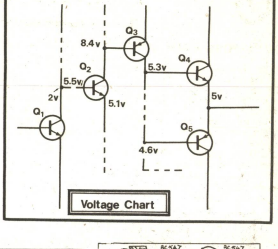
This project is an extension of the MINI AMPLIFIER described in issue number one. We have added a pre-amplifier to the front end to increase the extremely low output (50mv) of a moving-coil microphone to about 2v p-p to drive the amplifier fully. The moving coil microphone is actually a loudspeaker and can be used quite successfully if a small crystal microphone is not available. By using two small speakers in this project it would be quite easy for you to



add a reversing switch and make your own intercom. We haven't gone that far and are just using it as a single direction LISTENING BUG. By placing one microphone on a long length of speaker cable, you will be able to position the amplifier quite a distance from the noise source and be able to hear the conversation. It's ideal for parents catching up with all-night talkers who should be sleeping, or conversations during quiet study times. It may even be useful for detecting the first waking cries of a young baby!

TROUBLESHOOTING THE LISTENING BUG

The circuit can be considered as two separate stages. The pre-amp Q_1 as one stage and the remaining four-transistor direct-coupled push-pull amplifier as the other stage.
The first transistor is in an automatic self-biasing arrangement, in which the base voltage is derived from the collector voltage. This merely saves one resistor as compared with a bridge network. The transistor will operate with any voltage over about 2v on its collector. The other point to note is the base will need to have a small voltage on it to turn the transistor on. The 10mfd electrolytic blocks the DC voltage from the remaining section so that Q_1 can be considered as a completely separate circuit, DC wise.
The remaining four transistors operate as a complete unit since they are directly coupled to each other. So if the amplifier fails to function, where do you start?
The amplifier biasing commences with the 56k and 100k bridge resistors. They provide a base-bias of 5.5v for Q_2, the voltage comparitor transistor. The emitter voltage should be about 5.1v so that Q_2 is slightly turned on. This will make Q_2 draw current and produce a voltage drop across R_9, the 33k resistor. This voltage drop is the forward bias needed to turn Q_3 on. The load for Q_3 is provided by the 270 ohm and 1k5 resistors and these terminate at ground via the 8 ohm speaker. The 270 ohm resistor is designed to give the output transistors a slight forward voltage between the base and emitter leads to prevent 'cross-over' distortion. This distortion is reduced when the base-emitter voltage is nearing turn-on and the driver transistor doesn't have any wasted swing, turning on the output pair.
The common emitter junction of the two transistors should be about half the supply voltage as both transistors are turned off during the quiescent condition. Most of the amplification is performed by Q_1 and Q_3. The output transistors merely serve to take the delicate high-amplitude signal from Q_3 and take it in turns to "pump" it into the speaker via the 100 mfd electrolytic.



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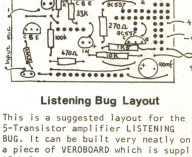
Next issue we will have three more projects for your PNP/NPN transistors.



Listening Bug Layout

This is a suggested layout for the 5-Transistor amplifier LISTENING BUG. It can be built very neatly on a piece of VEROBOARD which is supplied 15 holes wide and has a cut down the centre of the strip. With careful laying out you will not have to cut any of the copper tracks. Hopefully, when you first build the bug, it will not work. Then you'll be able to de-bug it. A voltage chart and trouble-shooting section will help you diagnose the fault.

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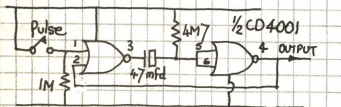
THE FULLY CHARGED CAPACITOR NOW ADDS ITS VOLTAGE TO THE OUTPUT GATE VOLTAGE AND WOULD EFFECTIVELY SUPPLY 18V TO PIN 2 IF IT WERE NOT FOR ANOTHER INPUT PROTECTION DIODE DIS-ALLOWING THE GATE VOLTAGE TO RISE ABOVE RAIL VOLTAGE. THIS MEANS THAT AT THE MOMENT OF SWITCHING, THE CHARGE FROM THE CAPACITOR IS REMOVED VIA DIODE D, SO IN EFFECT PIN 2 NEVER RISES ABOVE SUPPLY RAIL VOLTAGE. WITH THE CAPACITOR FULLY DISCHARGED, IT BEGINS TO RECHARGE AGAIN VIA R_1 AND THE HIGH ON PIN 4. THE SWITCHING SEQUENCE REPEATS ITSELF TO PRODUCE A SQUARE WAVE OUTPUT PROVIDED PIN 1 IS KEPT IN A LOW STATE. IMMEDIATELY THE PULSE BUTTON IS RELEASED, PIN 1 GOES HIGH AND THE MULTIVIBRATOR WILL CEASE WITH C_1 CHARGED.

THIS CIRCUIT IS EXTREMELY ECONOMICAL ON PARTS. IT REQUIRES JUST 2 EXTERNAL COMPONENTS TO PRODUCE A GOOD SQUARE WAVE WITH A FREQUENCY WHICH CAN BE VARIED FROM 1 CYCLE PER SECOND (1 Hz) TO ABOUT 30MHz, MERELY BY CHOOSING A SUITABLE RESISTOR AND CAPACITOR.

TIMERS:

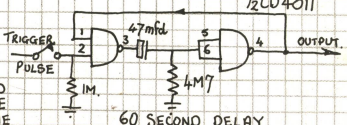
FOR FREQUENCIES BELOW 1 CYCLE PER SECOND (1 Hz) WE CAN USE EITHER OF THE CIRCUITS BELOW. A CD4001 OR CD4011 CAN BE USED AS A TIMER FOR DELAYS FROM 1 SECOND TO OVER 300 SECONDS. THE CIRCUIT WILL NOT "CLOCK". IT MUST BE RESET MANUALLY. FOR THIS REASON THE SWITCH SHOULD BE A MOMENTARY-CONTACT TYPE.



60 SECOND TIMER.

CLOSING THE PULSE SWITCH WILL START THE TIME DELAY. INITIALLY BOTH INPUT PINS 1&2 ARE LOW MAKING THE OUTPUT HIGH. THIS MEANS THE CAPACITOR IS IN AN UNCHARGED CONDITION AND PINS 5&6 ARE HIGH. THIS IN TURN CREATES A LOW ON OUTPUT PIN 4. THIS IS DIRECTLY COUPLED TO PIN 2 WHICH TAKES OVER FROM PIN 1 TO LATCH THE FIRST NOR GATE. THE CAPACITOR GRADUALLY CHARGES VIA THE 4M7 RESISTOR AND THE VOLTAGE ON PINS 5&6 RISES EXPONENTIALLY TO THE TRANSFER VOLTAGE WHEN OUTPUT PIN 4 CHANGES TO A LOW. PIN 3 GOES HIGH AND THE CAPACITOR IS IMMEDIATELY DISCHARGED VIA THE INPUT PROTECTION DIODES WITHIN THE IC. THE CIRCUIT WILL REMAIN IN THIS CONDITION UNTIL PIN 1 RECEIVES A TRIGGER PULSE.

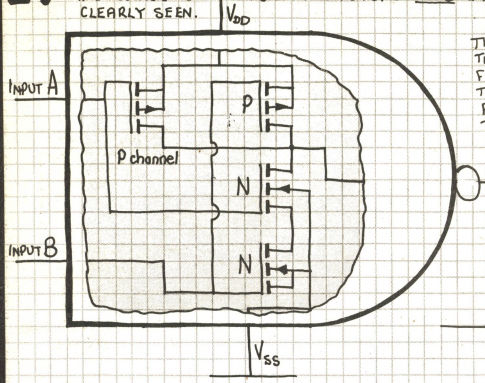
WHEN THE POWER IS CONNECTED A LOW IS PRESENT ON PIN 2. FROM THE TRUTH TABLE WE SEE THE OUTPUT MUST BE HIGH. THE UNCHARGED CAPACITOR MAKES PINS 5&6 HIGH SO THAT THE OUTPUT PIN 4 WILL BE LOW. THIS IS DIRECTLY COUPLED TO PIN 1 OF THE FIRST NAND GATE. THE CAPACITOR GRADUALLY CHARGES VIA THE 4M7 RESISTOR AND AFTER ABOUT A 60 SECOND DELAY, THE RISE ON PINS 5&6 CAUSE THE OUTPUT TO GO LOW. IT REMAINS IN THIS CONDITION.



60 SECOND DELAY

24

IN THE FOLLOWING DIAGRAM I HAVE REMOVED THE INPUT PROTECTIVE DIODES AND RESISTOR TO ENABLE THE ACTION OF A NAND GATE TO BE MORE CLEARLY SEEN.

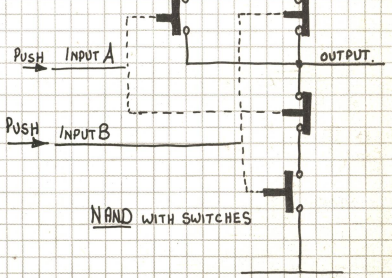


THE "GATE" OF EACH TRANSISTOR IS INSULATED FROM THE REST OF THE TRANSISTOR BY A THIN FILM OF SILICON OXIDE. THUS THE INPUT IMPEDANCE IS EXTREMELY HIGH.

VIRTUALLY NO CURRENT IS REQUIRED TO TURN THE TRANSISTOR ON OR OFF. EACH GATE REQUIRES LESS THAN 1 MICROAMP TO FUNCTION.

P CHANNEL & N CHANNEL TRANSISTORS CONNECTED TO FORM A NAND GATE.

THE NAND GATE CAN BE REPRESENTED BY 4-SWITCHES. BOTH INPUT A AND INPUT B HAVE ONE NORMALLY OPEN AND ONE NORMALLY CLOSED SWITCH, TO ACHIEVE THIS ACTION. PRESSING INPUTS A AND/OR B WILL HAVE THE SAME EFFECT ON THE OUTPUT AS THE ELECTRONIC NAND GATE

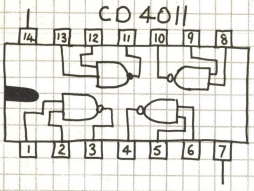


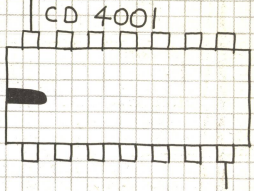
NAND WITH SWITCHES

25

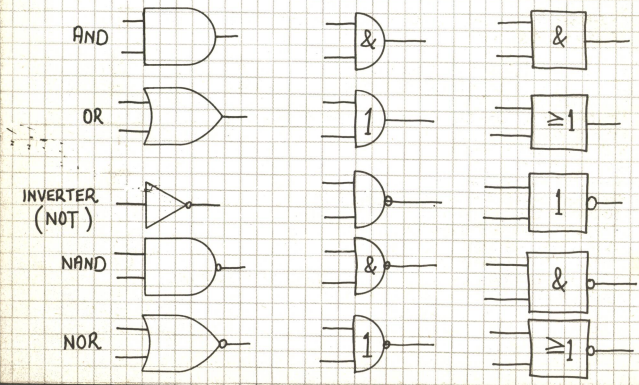
IN THIS DIAGRAM, THE NAND GATE IS SEEN INSIDE A CD 4011 INTEGRATED CIRCUIT. THE IC HAS 4 NAND GATES ARRANGED AS SHOWN. THIS ARRANGEMENT SUITS THE CHIP MANUFACTURING PROCESS AND ESPECIALLY THE TERMINATING PINS WHICH MUST NOT COME IN CONTACT WITH EACH OTHER. THE NUMBER OF NAND GATES IS LIMITED ONLY BY THE 14 PINS ON THE IC AND NOT THE SPACE INSIDE THE IC.

A SIMILAR ARRANGEMENT IS HOUSED INSIDE A CD 4001, WHICH YOU WILL FILL IN HERE:





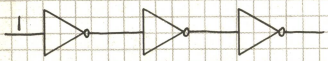
I HAVE USE THE USA-STYLE SYMBOLS FOR THE LOGIC GATES HOWEVER TWO OTHER CONVENTIONS SHOULD BE NOTED IF YOU WISH TO CROSS-REFERENCE WITH DIFFERENT MAGAZINES.



26 GATE QUIZ

USING BLOCKS 8, 9, 10, 14 & 15, TEST YOUR ABILITY TO TRACE OUT GATE CIRCUITS. THE HIGH OR LOW APPEARS SIMULTANEOUSLY AT THE INPUTS AS SHOWN. DETERMINE THE OUTPUT OF EACH OF THESE ARRANGEMENTS:

1.



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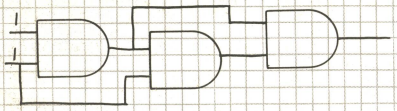

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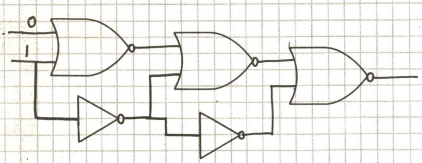

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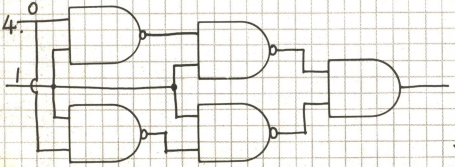

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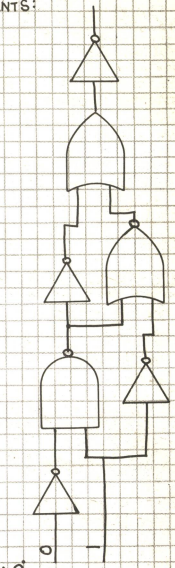

5. (a) DRAW 2 NAND GATES AND WIRE THEM TO FORM AN AND GATE.

(b) DRAW 2 NOR GATES AND WIRE THEM TO FORM AN OR GATE.

(c) HOW DO YOU CONNECT A NOR GATE TO FORM A NOT FUNCTION?

1-0 2-1 3-0 4-0 6-0

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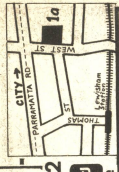

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SINGLE ROTARY POTS - LOG "C"
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100K,250K,500K,1M ea. 50c

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PRESET POTS-LINEAR "A"
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Note: Quantity Discounts May Be Mixed!

	Prices		
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4.7 uf	12c 15c	18c	
10 uf	13c 15c	18c	
22 uf	12c 15c	20c	
33 uf	15c 18c	25c	
47 uf	16c 22c	28c	
100 uf	20c 25c	40c	
220 uf	33c 40c	60c	
330 uf	35c 45c	70c	
470 uf	40c 50c	–	
1000 uf	60c 70c	–	

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	Prices			
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10 uf	18c	20c	22c	30c
22 uf	20c	22c	25c	30c
33 uf	20c	25c	30c	35c
47 uf	20c	25c	30c	35c
100 uf	30c	35c	40c	50c
220 uf	40c	55c	70c	80c
330 uf	50c	60c	80c	$1.00
470 uf	55c	70c	90c	$1.00
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2200 uf 63VW insulated can ea $2.50
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Reviewed in ELECTRONICS Aug.'79

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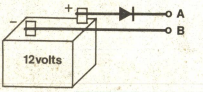
TEST YOURSELF... No 3

How good are you at identifying diodes? This quick test will give you a rating

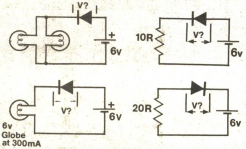
DIODES..

A DIODE may look an innocent 2-leaded package yet underneath the bland external appearance lies the first electronic component ever to be discovered. Even though it cannot amplify it is capable of performing over 12 different functions. We will consider only 3 of these in this test:

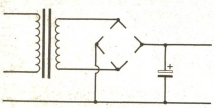
1. What is the voltage between terminals A&B?



2. What is the voltage across the diode in each of these circuits?



3. Draw a FULL-WAVE RECTIFIER BRIDGE:



4. When we measure a diode with a multimeter which has been set to "ohms" scale, we find its forward resistance reads about 20 ohms and when connected around the opposite way, has a reverse resistance of about 300k. What is the needle really telling us?

5. Why do some circuits show a FULL-WAVE BRIDGE RECTIFIER as:

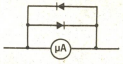
6. A FULL-WAVE RECTIFIER package has these symbols marked on the top:

(a) Match-up the identifying symbols on the top of the package with the four leads emerging from the base of the rectifier.

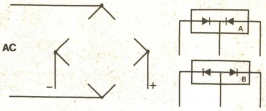
(b) Place the symbols as per the top of this rectifier onto the FULL-WAVE RECTIFIER diagram shown in Q.3.

7. When measuring a diode on a multimeter set to "Ohms x 1" scale, the reading is about 20ohms. Adjusting the range to "ohms x 1k", the forward reading is 10k ohms. Explain this.

8. Explain how the shunt diodes protect the micro-ameter movement.



9. Fit these 2 diode packages into the circuit diagram to create a FULL-WAVE RECTIFIER.



Answers

1. 12v - .6v = 11.4v Subtract .6v for any forward-biased silicon diode.

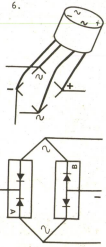
2. .6v appears across each diode except the fourth circuit. This diode is reverse biased and the full 6v appears across it.

3.

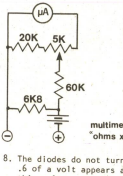
When drawing a bridge, remember the cathodes of the two right-hand diodes connect to the positive of the electrolytic and the anodes of the two left-hand diodes connect to ground.

4. The ohm-meter is really measuring a fraction of the voltage of the battery contained in the meter and this deflects the needle to full scale. Placing a diode in circuit with the leads effectively reduces this voltage by .6v and the needle responds accordingly. The same reading would be obtained if we presented a .6v supply in place of the diode.

5. A simplified schematic to show the general direction of the 4 diodes.

6. 

7. On the "ohms x 1k" scale, the multimeter has seen the diode as a .6v loss and the needle has deflected to the 10k position. Do NOT read this as 10k, just as a deflection.



8. The diodes do not turn on until about .6 of a volt appears across them. Below this voltage they are an open circuit as far as the movement is concerned. This means that no more than .6v can appear across the movement and it cannot be drastically over-loaded.

Score

We have not given a score for this test. Give yourself a fail or pass mark and enter the value here: [ ]

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We were recently shown a sample of these simple electronic kits and were quite impressed with their value and suitability for beginners. The instructions, however, were very poorly presented and contained almost no technical information on how the kits worked. We decided to help-out here and have compiled considerably better notes on the first four kits. Each issue we will review another four kits until they are all re-written. These kits are quite simple to build and we think anyone with a small soldering iron would be able to construct any of them in an hour or so. The four kits we are featuring in this issue worked first time and we hope you have just as much luck.

BEFORE YOU START

Check the contents of the kit against the layout diagram and make sure you can identify each of the parts. The transistors will need some special mention here as they are Japanese types and not only do they have unusual numbering, but are identified by the letters EBC when holding the flat side of the transistor towards you. This is "around the other way" to the BC 547, BC557 series which the magazine is specifying in the "TRANSISTOR PAGE". For this reason you will have to be extra careful when inserting them into the board.

The other point which we should mention concerns the printed circuit board. The copper tracks look like they are neatly tinned ready for soldering. Unfortunately they are not. They are nickel plated and this does not accept soldering very well at all. You will need to scrub off the plating with steel wool before starting. This will allow the solder to "take" to the board.

- SINGING BIRD
- RADIO
- ELECTRONIC ORGAN } THIS ISSUE
- TOUCH SWITCH
- MOSQUITO REPELLER
- ELECTRONIC TIMER
- SLEEPING BELL
- SOUND SWITCH
- PHOTO ELECTRIC SWITCH
- WATER PURITY TESTER
- POLICE CAR SIREN
- MORSE CODE
- FLASHER
- DECISION MAKER
- ELECTRONIC SIREN
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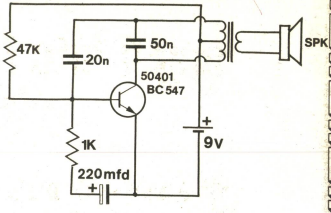
SINGING BIRD

The SINGING BIRD circuit is basically a blocking oscillator which is turned on and off at a slow frequency to give the effect of a chirping bird. The circuit looks very simple but needs some intensive explanation for you to fully understand its operation. This circuit form the basis of many of the kits and with a re-arrangement of parts, will produce a number of different sounds. Firstly we will consider the circuit as shown, minus the 1k resistor and 220mfd electrolytic. If we were to make this circuit it would oscillate at a fairly high frequency. It forms a blocking oscillator circuit in which the transformer performs a dual role. The primary of the transformer is centre-tapped. Signal-wise, this centre tap is a neutral point. When a signal flows through the lower half of the primary, it appears at the top of the primary with reverse polarity. Even though this winding is connected to the lower half via the centre tap, the voltage produced by it is derived purely by transformer-action. This occurs via the building-up and collapsing magnetic field inducing a voltage in the winding which is slightly delayed in time. We make use of this delayed voltage and feed it back to the base of the transistor via the .02 mfd capacitor. The 47k resistor provides bias to turn the transistor on. This covers every part in the circuit. When the battery is connected, the 47k resistor provides bias to turn the transistor on. This puts a heavy current through the lower half of the transformer and after a short time delay a signal of reverse polarity appears at the top of the transformer. This is fed to the base of the transistor via the .02mfd capacitor and turns it hard off. This is only a spike of short duration and soon the bias provided by the 47k resistor turns the transistor on again. The frequency of oscillation is determined by a combination of all the components we have listed including the effect of the speaker as a load on the transformer. When we add the 1k resistor and 220mfd electrolytic, not only do they alter the frequency dramatically, but they create the characteristic chirping of the oscillator. They effectively turn the oscillator on and off by the following method: The 220mfd electrolytic gradually charges via the 1k and 47k resistors and when the base voltage approaches about .8v, the oscillator turns on. It oscillates for a fraction of a second and in doing so, the spikes through the .02mfd capacitor are rectified by the base-emitter junction of the transistor and appear as a negative voltage to discharge the electrolytic. The voltage falls to below .6v and the oscillator turns off. The cycle then repeats itself.

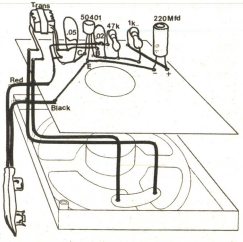


SINGING BIRD CIRCUIT

You can make this circuit from the kit or use any old transistor radio components. The wiring of the speaker transformer primary will have to be watched to make sure feed-back takes place. The transistor can be any NPN type, similar to BC 547.

EXPERIMENTS: Three interesting experiments can be performed with this project:

1. Remove the 220mfd electrolytic and notice the change in frequency.
2. Connect another 220mfd electrolytic across the battery leads where they enter the PC board. Disconnect the battery and notice the change in frequency as the voltage dies down.
3. Touch the .05mfd capacitor with a warm soldering iron while the oscillator is functioning. Can you see why we don't use this type of capacitor in high-stability oscillator circuits?

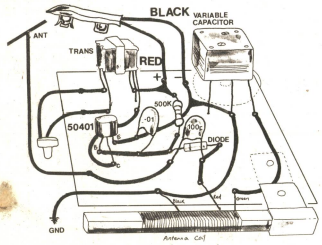


SINGING BIRD LAYOUT

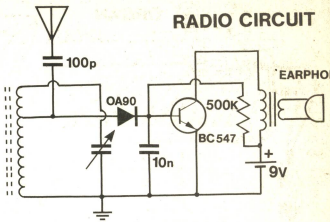
RADIO

The RADIO KIT is really a crystal set with a one transistor amplifier. The signal is picked up by the aerial and fed to the tuned circuit consisting of the aerial coil and tuning capacitor. This RF signal is passed to the diode where it is converted to an audio frequency signal. This is fed to the base of the transistor which amplifies it about one hundred times to make it loud enough to hear in comfort. The transistor is coupled to the low impedance earpiece via a small transformer The transformer provides impedance matching and allows the transistor to maintain a high voltage swing with low current flow whereas the earpiece requires a higher current flow and needs only a small voltage swing.

For this "RADIO" project to work properly you will need an aerial and an earth. Ideally the aerial should be about 10 to 20 metres long and as high as possible. This usually involves taking up the whole of the back-yard with a high "clothes-line", but if this is a bit impractical, you can try the metal of the telephone dial or your TV antenna. For an earth you can use the cold-water tap or the frame-work of the sink. Don't expect to get fantastic results because we didn't! We didn't get very good station separation either. In fact we only got one station at the low frequency end of the band. Maybe you will get better results with a good aerial, but if not, don't despair. The components from this project will be handy when we build a simple 3 or 4 transistor TRF radio which will be a portable type.



RADIO LAYOUT

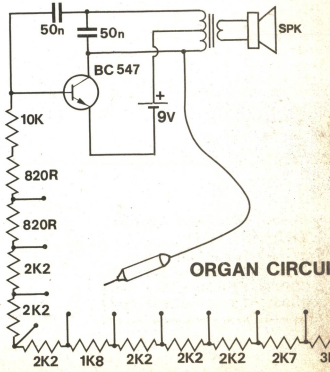


ELECTRONIC ORGAN

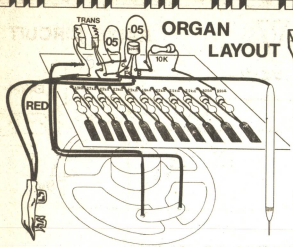
This circuit is identical to that of the SINGING BIRD. It is a blocking oscillator circuit in which a chain of resistors is used to modify the base bias. It does not matter whether the probe lead is taken off the centre tap of the transformer or either end, it is purely providing a DC bias.

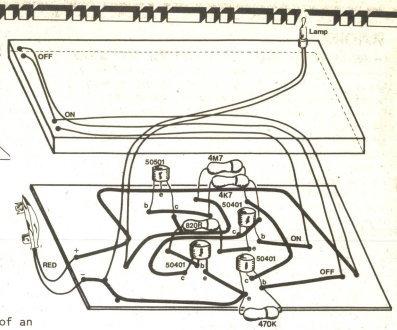
The scale of this organ has quite a useful range and simple tunes can be played on the copper side of the board as it is etched in the form of a simple keyboard. This is quite a neat little toy and is normally more expensive than the other kits and so provides good value as well as hours of fun.

Try tapping the probe on the end of the other components and even put your fingers on the copper side of the board. You will be surprised at how many other sounds can be generated.



ORGAN CIRCUIT





TOUCH SWITCH

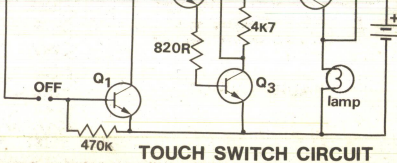
The TOUCH SWITCH circuit consists of 4 transistors and a small globe. In place of an ON-OFF switch is a set of 4 studs and the circuit makes use of the resistance of the skin of your finger to turn the globe ON and OFF. When the battery is connected, the globe will be extinguished. Touching the ON terminals will provide a voltage of about 2v on the base of Q2. The reason why this voltage must be over 1.2v is due to Q2 and Q3 being arranged as a super-alpha pair. It provides very high gain with very high input and requires few components. To turn Q2 ON, we have to provide the base-emitter voltage for Q2 as well as Q3. When these turn on they provide a forward bias for Q4 via the current limiting resistor:4k7. When Q4 turns on, the collector-emitter voltage falls to about 1v and the lamp is provided with near-supply voltage. This 8v is also supplied to the 4M7 resistor and since we said the input impedance of the super-alpha pair is very high (Q1 can be effectively neglected in this part of the discussion) the resistor will provide enough forward voltage to keep the three transistors turned on when your finger is removed. The 4M7 resistor is called a feed-back resistor.

TOUCH SWITCH LAYOUT

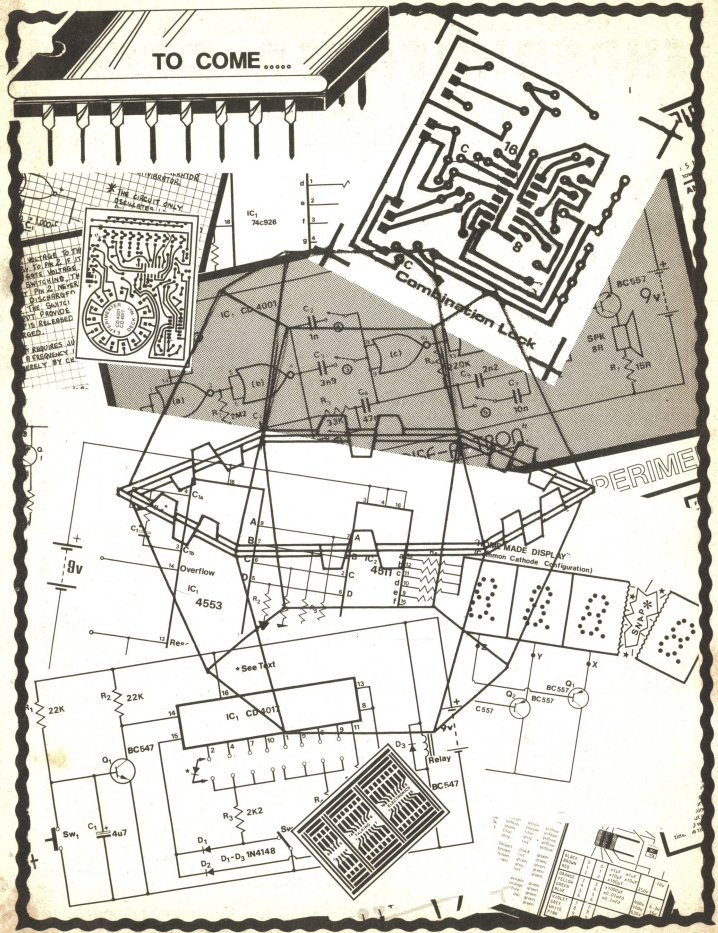
Now let us deal with the off section.
Q1 is effectively biased off via the 470k resistor but when you put your finger on the OFF studs, the transistor will turn ON. This will reduce its collector-emitter voltage to about 1v, which is less than that required to keep the super-alpha pair turned ON and thus the globe will be extinguished.
You will notice this circuit has a fairly rapid snap action due to the 4M7 feedback resistor. If you find the globe to be fairly dull on 9v you can safely increase the supply to 12v. The globes supplied are actually 12-15v @200ma. The quiescent or standing current of this circuit is only about .7ma so a large 6v battery such as 509, can be left connected for about 12 months.

We will be able to think up lots of ideas for this type of circuit so it would be wise to make up one of these circuit and see first-hand how they work.

TRANSISTOR EQUIVALENTS
CS9013=E50301=BC547 NPN
CS9014=E50401=BC547 NPN
CS9015=E50501=BC557 PNP



TOUCH SWITCH CIRCUIT


TO COME.....
Combination Lock
IC1 74c926
IC1 CD4001
IC1 4553
IC1 CD4017
Overflow
9v
22K
BC547
Relay
4u7
D1-D3 1N4148
2K2
3n9
2n2
10n
15K
47K
BC557
SPK
8R
+See Text
Common Cathode Configuration)

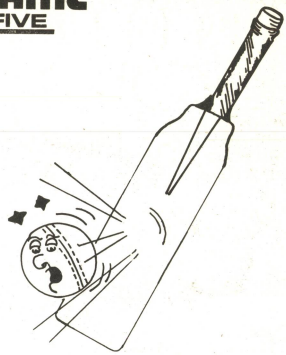
....Continuing our series on the

EXPERIMENTER DECK

CRICKET GAME

PROJECT FIVE

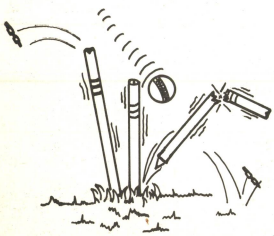
The three projects this month use the same circuit... The RUNNING LIGHT circuit.
We adjust the speed of the decade counter to suit each project.



The complete circuit for this month's three projects has already been fitted to the PC board. You will only need to wire in a switch for the second player to make the running light into a cricket game. This means, by adjusting the pre-settable jumpers you will be able to operate the running light in three different modes. This will create three different effects. Not exactly completely different but a variation in presentation. These three projects are designed for two players and you will be able to match your reaction time with that of your friends. And you will be able to do it digitally.

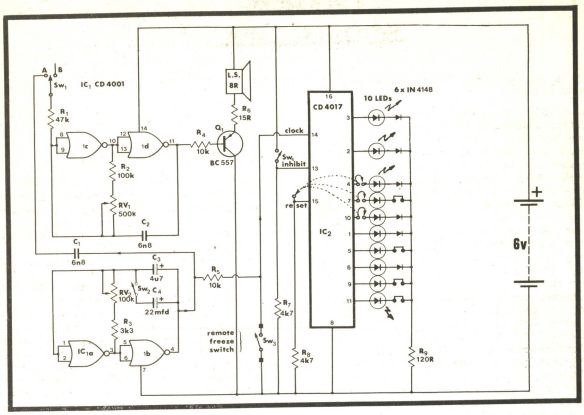
PARTS

1 - Push-to-make switch.



PROJECT FIVE IS A CRICKET GAME. It's only a simple, basic game with scope for improvements such as a fancy box, coloured decals and even miniature figures playing cricket with toy wickets and bat. One player becomes the batsman. He holds the BATTERS SWITCH. The BOWLER uses the jumper on the Experimenter Deck to reset the counting IC to zero. On the circuit diagram the BATTERS SWITCH is labelled "remote freeze switch" and is connected to the circuit at the negative terminal and pin 14 of the CD 4017. A square solder land is provided at these two positions for the switch. The switch "shorts out" the incomming pulses from the CD 4001 and prevents them entering the CD 4017. A 10k resistor separates this short from the CD 4001 to prevent it being damaged.

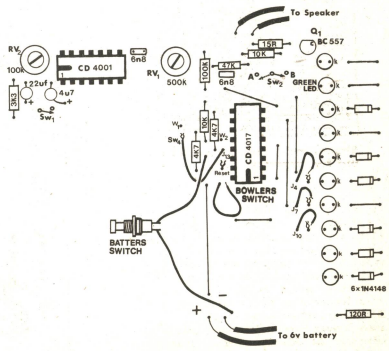
The game commences when the bowler removes his jumper from pin 15. This clocks the CD 4017 and the LEDs begin to run towards the wicket. The batsman attempts to hit the ball when the green LED is illuminated. If he pushes his switch and freezes the action on the green LED, it is counted as a run. Normal scoring can be used with the winning player gaining the highest score before being bowled out. The very last LED indicates a fallen wicket. If this lights, the batsman is "bowled" and players change positions.



Cricket Circuit (AND TIMER, AND REFLEX)

With slight additions and alterations the RUNNING LIGHT circuit becomes a cricket game. The reset jumpers from LEDs 3, 4 and 5 are returned "HOME". The re-setting is now done from the positive line where you will be able to reset the IC at any instant to begin each game from LED number 1. The switches can be improved and mounted into separate boxes to allow the batsman and bowler to gain better control of the action.

The 10k pot is adjusted to give the speed of the ball. As the competence of the players increases, the speed can be increased. To gain co-ordination between players, I suggest running the ball at a fairly slow speed at the beginning and working up to the impossible rate where the pot is fully closed.



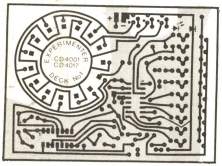
CRICKET LAYOUT

TIMER

PROJECT SIX

What is the use for a "LIGHT-TIMER" or a "SOUND-TIMER?"

Production-line assembly work quite often requires a sound to indicate the end of an operation. This allows the workers eyes to be kept free to concentrate on the operation. The same applies to photographic work. The operator cannot afford to take his eyes off the development process and since the level of illumination in a dark-room is low, it would be difficult to see a clock.
In fact any routine assembly or manufacturing process could utilize an audible alarm. This project provides a suitable basis for a handy timer that gives an audible as well as light readout. It is capable of timing from one second to about 40 seconds. With alterations to the timing capacitor and resistor, it can be extended to about 2 minutes. However, as it stands, it is only capable of a short time delay. Since there are 10 LEDs, a visual record of time elapsed can be seen during the delay. This means the audible and visual facilities can be used in conjunction so that full concentration can be awarded to the operation in hand.

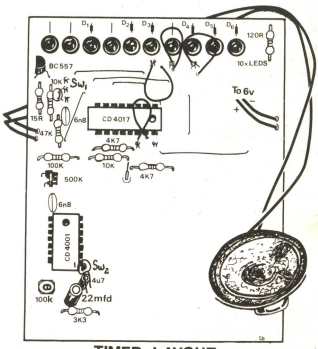


Shaded area covers the soldering for projects 1-7.

Adjust the 100k mini trim pot to give 2 seconds per flip and 2 seconds per flop. You can experiment with longer time intervals but you will find a point will be reached where the IC will not have a guaranteed start. The molex-pin switch Sw_1 will give you this longer time delay by bringing the 22mfd capacitor into circuit.
Even longer time delays are possible with the CD 4001 IC, however this involves a different circuit which does not "cycle".

HOW THE CIRCUIT WORKS

Basically it is a running light circuit slowed down to about 2 seconds per flip and 2 seconds per flop. The CD 4017 counting IC only counts after each flop so you will hear a high and a low note while each LED is lit, making a total time of 10 x 4 seconds or about 40 seconds. To create a universal timer for time delays up to 2 minutes or more, it would be necessary to change the 100k mini trim pot to a 500k mini trim pot in conjunction with a 10mfd tantalum capacitor. Since time delays over 5 seconds per cycle become unreliable with this type of circuit when using a low voltage, it is not recommended that you try to extend the cycle over 5 seconds. However as time delays up to 2 minutes can be achieved, you will be able to achieve time intervals of 4 or 6 minutes by repeating the sequence.



TIMER LAYOUT

TEST YOUR REFLEX TIME

PROJECT SEVEN

Catch up with the New Decimal time

When driving a car we pride ourselves as having an "instant reflex" to avoid danger. When walking down the street we may duck away from the appearance of a foreign missile coming towards our eyes. We may think these are instantaneous reactions but they must take some fraction of time, no matter how short. In fact, the reason for our eyelashes is not to promote mascara but protect our eyes from flying objects. Our eyelids are capable of closing as soon as the eyelashes detect an impulse and cover the eyes before the object has time to travel the last centimetre.
Some parts of our body have a very fast reaction-time, others are much slower. The reflex-time we are interested in involves our "eyes-brain-hands" co-ordination.
We test it in this manner:
The RUNNING LIGHT circuit is set up to time to 1/20 second. To achieve this, the CD 4001 must oscillate at 20Hz so that in one second it will clock the CD 4017 20 times. This will run the LEDs twice down the row and gives the following table for each LED:

LED	TIME
1	0 sec
2	.05 sec
3	.1 sec
4	.15 sec
5	.2 sec
6	.25 sec
7	.3 sec
8	.35 sec
9	.4 sec
10	.45 sec

To obtain an accurate 20Hz frequency you will need an ordinary watch with a seconds hand. Adjust the 100k pot and count the number of times the 10th LED lights up. When it blinks 20 times you have a 20Hz oscillator. Use this frequency to clock the CD 4017. The object of this game is to freeze the LEDs as soon as possible after they begin to run. Two players will be needed, one to start the LEDs running while the opponent attempts to freeze the motion. Since the first LED must be lit to commence timing, each additional LED represents .05 seconds.

We conclude this series next issue with the most interesting section...making music. We will be adjusting the frequency of an oscillator by adding capacitance to the input circuit and clocking these capacitors at a set rate or a variable rate to give different effects. This will be the beginning stages of the purpose of our **very existence**. As our name conveys, we will be introducing the ultimate in electronics... that of talking modules. These all rely on a generated sound and in gradual stages we hope to achieve simulated sppeeecch.

Quiz:

You must answer these questions, otherwise don't buy issue 4.

These items were introduced in this issue. Describe their function:

1. 7805:

2. CD 4024:

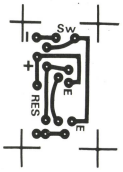
3. EM 401:

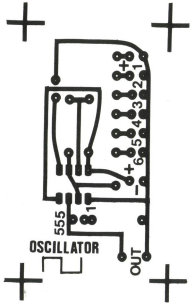
4. Explain in 6 lines how we "one shot" a 555.

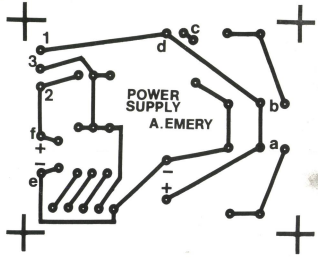
5. Explain in 4 lines how a Bridge Rectifier changes 50 Hz to D.C.

6. What is the difference between a 7805 and a 7812 voltage regulator?

Printed Circuit Board Artwork







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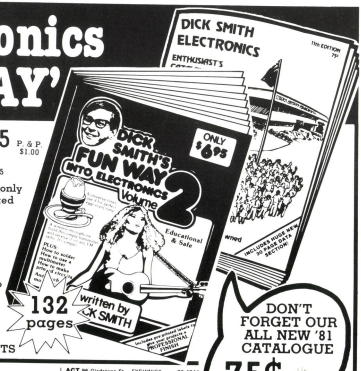

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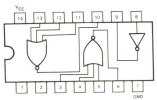
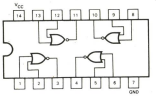
DATA

CD4000



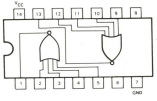
DUAL 3-INPUT NOR GATE PLUS INVERTER

CD4001



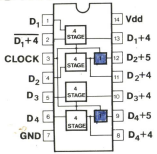
QUAD 2-INPUT NOR GATE

CD4002



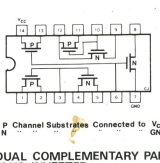
DUAL 4-INPUT NOR GATE

CD4006



18-BIT STATIC SHIFT REGISTER

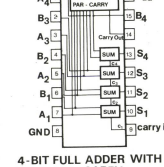
CD4007



All P Channel Substrates Connected to V_{CC}
All N Channel Substrates Connected to GND

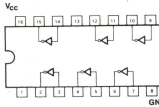
DUAL COMPLEMENTARY PAIR PLUS INVERTER

CD4008



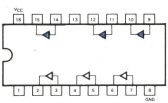
4-BIT FULL ADDER WITH PARALLEL CARRY

CD4009



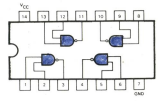
HEX BUFFER (INVERTING)

CD4010



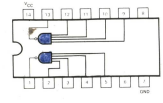
HEX BUFFER (NON INVERTING)

CD4011



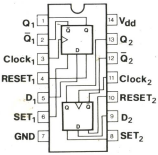
QUAD 2-INPUT NAND GATE

CD4012



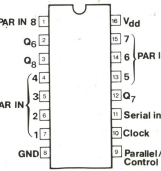
DUAL 4-INPUT NAND GATE

CD4013



DUAL D FLIP-FLOP

CD4014



8-BIT STATIC SHIFT REGISTER

CPW